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PLATE XV.



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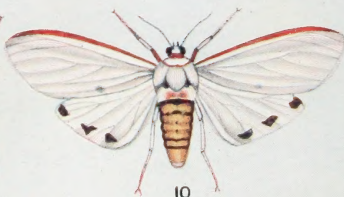
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MOTHS OF HAIRY CATERpillARS.

HAIRY CATERPILLAR PESTS OF CROPS.

By H. MAXWELL-LEFROY, M.A., F.Z.S., F.E.S.,

Imperial Entomologist, Agricultural Research Institute, Pusa.

AMONGST the many injurious insects in India, one small group may clearly be distinguished both in appearance, habits and destructive effects upon crops. These insects are familiar to cultivators in their immature but destructive stage when, as hairy caterpillars, they appear in vast swarms and ravage whatever green crops may be on the ground. These swarms of caterpillars are a very distinct feature in some tracts, appearing at definite seasons, lasting for short periods only, and re-appearing after some weeks' interval. So much the cultivator sees and knows, but this caterpillar stage is the only one of the insect's life familiar to him. When the caterpillars have eaten their fill of the crops, they disappear naturally, but unfortunately they are not, as would appear, dead or devoured by birds. They re-appear in their final stage of life as moths. In this stage they are not generally familiar, certainly not to the cultivator and perhaps only to the few who may happen to know something of the natural history of the insect. Yet as moths, they are very easily and distinctly recognisable, and their appearance in the field or at a lamp by night is a valuable indication of the probable occurrence of the pest in its destructive form during the following few weeks.

The life of the insect from stage to stage is best illustrated by the entries on the cage slip of the Pusa Insectary referring to the "Orange Sann Moth" (Plate XV, Figs. 1 and 2). The entry is as follows:—

4th August :	Eggs laid by moth on the leaves of sann hemp (<i>Crotalaria juncea</i>), in a breeding cage.		
8th August :	Eggs hatched.		
	Caterpillar	2 mm.	($\frac{1}{15}$ in.) long.
17th	"	7 mm.	($\frac{3}{4}$ in.) long.
21st	"	16 mm.	($\frac{2}{3}$ in.) long.
24th	"	25 mm.	(1 in.) long.
25th	Pupation commenced.		
31st	Moths emerged.		

6th September :	Moths laid eggs.
8th "	Eggs hatched.
19th "	Caterpillars full grown.
21st "	Pupation commenced.
28th "	Moths emerged.

Here we have two complete life cycles in less than two months. At two periods, about August 21st and September 17th, the cultivator would see caterpillars eating his crop, and again at two other periods, August 4th—8th and September 1st—6th, he would perhaps see moths ; if he connected the two occurrences, he would, on seeing the moths, anticipate the next brood of caterpillars and be ready to destroy them.

It is this aspect of prevention that I wish to bring forward, the recognition of some of our commoner insects in the perfect condition, that is, as moths when they are about to lay eggs. This group (hairy caterpillars) is the best example of the value of recognising the perfect insect as an indication of approaching pests, because the moths are extremely characteristic in appearance and are found either flying in the fields by day or round lights at night.

An instance also of the value of this means of anticipating pests may be given in the method adopted of checking the Behar hairy caterpillar. During 1904, this caterpillar ravaged certain crops on the Pusa Experimental Farm which was then being brought into cultivation ; appearing in great numbers, they devoured certain favourite crops and at several periods were a serious menace to part of the cultivation. All that could be done at that time was to rear the caterpillars to moths and determine their identity. In the following year the first moths were seen in March ; a search for them was made in the crops, and their eggs were first found and destroyed about the 20th of that month. They re-appeared in May, were again searched for on crops and many eggs found and destroyed. The next brood was expected on June the 22nd but did not appear ; no caterpillars were found, and the absence of the brood was attributed to the unusual lateness of the rains. The rains finally broke about July the 22nd, when moths were again seen ; their eggs were collected in the fields from July the 26th to August the 1st. Another and final brood was seen on September the 11th, and a small number of eggs was discovered and destroyed. Throughout the season nothing else was done. When the moths were seen at lights or sitting on walls, a watch was kept for eggs laid in the fields, and when these were discovered, both the eggs and young caterpillars were destroyed. A common labiate weed, as well as the sann hemp, til (sesamum), sunflower and groundnut crops, were examined for eggs. At a very small cost

for labour and supervision, the farm was kept clear of an injurious pest that would otherwise have done great harm, or necessitated laborious spraying operations.

This case was an exceptionally valuable one, as the broods reappeared several times and the value of the method was conclusively shown. In other species there are fewer broods, and an outbreak may be anticipated only twice during the rains. There is also the further consideration that, if the late batches of eggs are secured, the pest has not time to breed several times in succession, and become very numerous during that year.

In almost all cases of large caterpillar outbreaks, the fact that the moths are seen beforehand is a valuable indication, but it is naturally impossible for the untrained mind to recognise more than a few very characteristic insects. It is for this reason that I figure the moths of these hairy caterpillars, which are most characteristic, which usually attack definite crops, and which appear near lights or in the fields at fairly regular seasons. The essential and vital fact is to foresee the attack of caterpillars, if possible, and to destroy the eggs or young caterpillars before the latter are large enough to wander. For this reason the recognition of the moths of these caterpillars is of great importance, for there is no other easy method by which such swarms can be successfully checked. The moths of the common species are figured in Plate XV, and the representations give so accurate an idea of the insects that there should be little difficulty in identifying them.

The "Orange Sann Moth"† (Figs. 1 and 2) lays its eggs on sann hemp and wild *Crotalaria*. It is common in the plains, widely scattered, and attacks this crop during the rains. Depending on the supply of food, there may be five broods in the year, but there are usually about three. The moth is likely to be seen at any time in the rains: it is not attracted to lights but is very easily discovered in the fields, as it flutters about among the sann hemp plants. The eggs and young caterpillars are found in clusters on the leaves and should be picked off and burnt.

The "Crimson Sann Moth"‡ (Figs. 3 and 4) is a rare insect, but behaves similarly to the Orange species and has been found to be equally destructive when abundant. The "Red Spotted Eroding Moth" (Figs. 5 and 6) is another very distinct species common in the plains, also attacking sann hemp. It flutters about in the daytime and the moths are readily seen and recognised. Like the Orange Sann Moth, its eggs or caterpillars should be looked for when the moths are seen in the fields. The "Eucalyptus

† *Acraea cathartica*, Ck.

‡ *Acraea cathartica*, Ck.

§ *Heliothis prodenioides*, Linn.

Moth"† (Figs. 7 and 8) is common in Behar, Ondh and in some localities near the hills, and is possibly a hill species that spreads into the neighbouring plains. It is very abundant in Behar, attacking sunflower and leguminous plants, and also ravaging cotton and various crops if other food fails. The moth is attracted to lights or may be seen sitting on walls, and in favourable years there may be as many as six broods in the year.

The "Red-banded *Amsacta*"‡ (Fig. 9) is found widely but less abundantly distributed over India. It appears to be very abundant only at long intervals, and specially attacks groundnut crops. The moth is like the following one but is distinguished from it by its red abdomen. The "Orange-banded *Amsacta*"‡ (Fig. 10) is a larger insect, also attracted by lights, or, if disturbed, found flying in the fields. It has a wide distribution and attacks sweet potato, sunflower, rice, sesamum and sorghum. Its development is slower, and there is a smaller number of broods in the year. Like others it may be looked for first in the early rains, but as it eats wild food-plants, it may not be found in the crops unless exceptionally abundant.

A commoner insect is the "Black-streaked *Creatonotus*"§ (Fig. 11), a moth which is easily recognised by the interrupted black streak in the fore-wing, which is not so white as in others. The moth comes to lights and may be seen in abundance. So far as is at present known, it is the only common moth of this kind which is harmless, and if seen, no outbreak of caterpillars on crops need be expected. It will probably be found to attack crops in time of stress, but is not one of the major important insect pests. Finally there is the little "Black-lined *Amsacta*", a smaller insect with pinkish fore-wing having a narrow, black line. With the orange-banded species, this appears in the rains; its caterpillar is familiar in Baroda and Gujarat as "*Katra*" and occurs generally over India. This is one of the many caterpillars that attack indigo, and in a bad year many other crops suffer from its ravages.

The above eight insects comprise the known injurious species and, though others will be found, these are the only ones of general importance in India. We may add that the term "hairy caterpillar" is meant to apply only to caterpillars eating crops. It does not here include the hairy caterpillars (e.g., the "*Kumbhi-Poochi*" of Mysore) found on trees nor the many hairy caterpillars found in jungle or forest land.

† *Amsacta phlegon*, Wied.

‡ *Amsacta* sp. Butl.

‡ *Amsacta lactinea*, Grav.

§ *Creatonotus atagis*, Linn.

Amsacta *torcula*, Grav.

These moths lay eggs in the same characteristic manner, depositing as many as fifty, sixty or even a hundred, in a cluster on the underside of the leaf of the food-plant : such clusters are irregular, and look as if a pinch of poppy seed had been put on the leaf and then stuck to it, with a sprinkling over it of short hairs. The moth lays several such clusters ; a female orange-banded *Amiseta* laid nearly six hundred eggs in the inscary, 530 young being counted when these eggs hatched. The egg clusters are on the lower side of the leaf as a rule ; it is not difficult to find them if one walks through the field when moths are seen ; and if all are not seen, the caterpillars are easily obtained when they hatch.

The little caterpillars hatch out together and feed first on the leaf they are on and those close by. One then sees a plant of which some leaves are eaten or spotted, the caterpillars either eating the leaf entire or nibbling the epidermis on both sides, giving the leaves a peculiar spotted appearance. A day or two later, the caterpillars have spread a little, and one sees a group of plants of which the leaves are totally destroyed, the little caterpillars then beginning to spread. They are still gregarious enough to be found in groups on the leaves, and it is then only necessary to pluck and destroy the leaves on which there are caterpillars. A basket or kerosene tin is required in which to collect the leaves, the leaves being burnt, or buried in the soil, or simply shaken over a vessel containing water on which a little kerosene is poured, when the caterpillars fall in and are killed. The vital factor in checking these pests is to recognise the moths, and when these are seen, to watch in the field for eggs or for the young caterpillars. The latter are found a few days after the moths are seen and are the most easy to detect, but when moths are actually seen in the crops, there is usually little difficulty in finding the eggs there.

EXPLANATION OF PLATE.

- Fig. 1. Orange Sawfly as seen flying in the field.
 Fig. 2. " " " as seen resting on a leaf.
 Fig. 3. Greenish Sawfly as seen flying.
 Fig. 4. " " " as seen resting.
 Fig. 5. Red-spotted Krimm Moth as seen flying.
 Fig. 6. " " " as seen resting.
 Fig. 7. Dorsal Moth as seen flying.
 Fig. 8. " " " as seen resting.
 Fig. 9. Red-banded *Amiseta* as seen flying.
 Fig. 10. Orange-banded *Amiseta* as seen flying.
 Fig. 11. Black-spotted *Ephestia* as seen flying.
 Fig. 12. Black-headed *Amiseta* as seen flying.

FLAX EXPERIMENTS IN INDIA.

By BERNARD COVENTRY,

Director, Agricultural Research Institute, Pusa.

CAN flax be grown and manufactured in India? This is a question which has exercised the minds of individuals and of the Government of India for over a hundred years, which is still being asked to-day, and still remains unanswered. India produces 300,000 tons of linseed per annum valued at about 3 millions sterling. The plants from which this seed is derived are either thrown away or used as fuel. It is only natural that this country should have been looked to as a source of supply by those interested in the production of flax, and the saving of the fibre from destruction has been a cause of keen speculation to many.

The earliest attempts to produce flax in India appear to have been made at the beginning of last century by Roxburgh, in a Hemp Farm established by the East India Company in the neighbourhood of Calcutta. His experiments were confined to the Indian linseed plant, and though samples were prepared and sent to England, no definite conclusions are recorded as to whether the trials were a success or not.

In the year, 1839 the matter was taken up more seriously, and a Company was formed, having as its object the growth of flax in India. Riga and Dutch seed was imported, as it was thought probable that the Indian plant, which had for centuries been grown for the production of seed only, was not as good for flax production as the Russian and Dutch varieties, grown in those countries principally for fibre. The subject was warmly taken up, and extensive experiments were carried out, principally in Bengal. Samples of fibre were valued in England at £30 to £45 per ton, and a very favourable view was taken of the probabilities of a profitable enterprise. The Agricultural Society of India, as the result of a request from Government in 1841, submitted a report of these results, and we find the Revenue Secretary to the Indian Government writing to them on the

22nd November 1841, that, "the cultivation of flax can no longer be considered a doubtful experiment, since it appears from your report to have been found in many instances successful, and where successful, to be very fairly profitable. His Lordship in Council is, therefore, much inclined to doubt whether any bounty or reward from Government is necessary or would be justifiable." Notwithstanding these favourable results, the Company did not continue the experiments, and the inference to be drawn is that the refusal of the aid, for which they applied to Government, forbade their risking any more in the venture. Indeed we find Mr. Wallace, who conducted trials for three years, stating in 1841 that the speculation must be abandoned unless the Government gave some encouragement.

In 1856 and following years, the subject was again revived, and we find experiments started in the Punjab, N.-W. P. and other parts of India with both indigenous and imported Dutch and Riga seed. In a letter addressed by the Personal Assistant of the Financial Commissioner to the Government of the Punjab, dated the 20th July, 1859, the results of the experiments in the Punjab are stated. The price realised in England for the fibre varied from £35 to £45 per ton, and the results are described as being "most encouraging and gratifying." "It has now been experimentally proved that flax grown from country seed in the Punjab can command a first class price in the European markets, leaving a large margin to cover cost of transport, &c., and for profit. The question may, therefore, be said to have passed from the stage of speculation and surmise to that of fact."

Reports of Dr. Jameson, Superintendent of the Saharanpur Botanical Gardens, written in the year 1859, give the following information. The height of the plant was $3\frac{1}{2}$ to $4\frac{1}{2}$ feet. The yield of seed per acre was 7 maunds, and the yield of fibre per acre was 4 maunds. The proportion of fibre to straw was 25%. He says in the reports referred to, "I found that flax might not only be made an excellent paying crop from the seeds alone, but that the stem or shove, if properly scutched, would be admirably fitted for the Home market, but before this can be brought about, it would be absolutely necessary to import good instructors from Europe."

A Committee composed of members of the Agricultural Society of India was appointed for the purpose of investigating the question of "the cultivation and manufacture of flax in India." After reviewing the past and present history of the subject, they stated that the work in order "to afford any hope of success must in the first instance be carried on under European supervision, as the raising of the plant for fibre is unknown to the natives, and the manipulation requires much nicety and judgment." They indicated what aids they considered were necessary, and recommended the "engagement

for one, two, or three years, of persons who are well acquainted with the mode of cultivating and preparing flax after the most recent improved methods." On the 8th March 1860, we find the Secretary to the Government of the N. W. P. addressing the Secretary to the Government of India, to the following effect: "It appears that not only can an excellent paying crop be obtained from the seeds alone, but that the fibre prepared under proper management would be admirably fitted for the home market. This is found to be the case not only by the results of Dr. Jameson's experiment, but also by the results of those conducted on a larger scale in the Punjab—the flax which was there produced having been declared by competent home authorities to be even superior to the Russian flax." The letter goes on to say that "instruction from Europe is indispensably necessary before native cultivators will be able to carry out the somewhat difficult processes described by Dr. Jameson," and suggests "for the consideration of His Excellency the Viceroy that measures be authorised for the engagement of a couple of competent European Instructors, and the importation of the necessary machinery and seed." To this, the Government of India replied in a letter, dated the 3rd October 1860, that "the experience of success gained in the Punjab should be sufficient to stimulate private enterprise to seek a field for its operations," and that as the practicability of cultivating flax for the English market at a good profit had been clearly established in the Punjab, which could now be left to its own progress unaided, it did not appear that the assistance of instructors was required in the N.-W. P. The Government, however, offered assistance in various other ways, such as the dissemination of literature on flax, aid in the importation of seed and machinery by passing it duty free, rewards and prizes for the production of the best flax, and the loan of the services of Belfast men from European regiments who were acquainted with the art of flax manufacture. These offers were evidently not considered to afford sufficient help, and the subject lapsed once more into oblivion.

I have been careful to quote at some length from the reports and correspondence on past trials, because it is generally assumed in the present day that, experiments having been so repeatedly made and no practical results having emanated from them, the growth and manufacture of flax in India has never been and is never likely to be a success. The object of this article is to show on the contrary that there is no warrant for such a conclusion and that past efforts so far as they went pointed to success. In other words it would appear most probable that flax can be properly grown and manufactured in India, and that if the Government in 1860 had provided European Instructors and aided the birth of the undertaking one step further than

they did, the country would in all probability have possessed an industry at the present day not in any way inferior to that of Jute.

I propose now to consider the experiments which are at present being conducted in Behar. The decline of the Indigo industry, owing to the appearance in 1897 of the synthetic dye, has stimulated the planting community in Behar to seek new fields for their enterprise and capital. Among the new endeavours is the culture of flax. At present only two places have taken the matter up, namely, the Dooriah Indigo Concern in the district of Muzafferpore, of which Sir Lewis Hay, Bart., and others are proprietors, and the Rajpur Indigo Concern in the district of Champaran owned by Mr. E. Hamilton Hudson and others. The Rajpur Concern has only recently sown down a limited area, the results from which have not yet been ascertained, so that the only useful information at hand is that obtained from the working of the experiments in the Dooriah Concern. The writer paid a visit to this concern in May last and collected what information was then available, and has since received from the Manager, Mr. J. Cameron, further particulars up to date.

The Dooriah Concern has been experimenting in flax for the past four years. Over 100 acres are under cultivation, and they have erected scutching machinery, which turns out 250 lbs. of prepared fibre per day. With skilled workmen it would probably turn out three times that amount. The cost of machinery is comparatively small, that required for all the processes of 'breaking' 'scutching' and the like being about Rs. 2,000. The process of manufacture is as follows:—The plant is cut down when nearly ripe and "rippled" for seed. The stalks are then either retted green, or dried and stacked, and afterwards retted at leisure. The Russian and Irish methods of retting are considered unsuitable for India. Of other methods, the retting of the dried straw as practised in the River Lys in Belgium, where the finest flax has been produced for years, is considered the best, as it facilitates the work by extending it over a longer portion of the year when other work is slack. This process is worked by packing the dried stalks in crates lined with cloth, so as to secure filtration of the water, and then retting at least twice in running water. Great care and judgment is required to regulate the retting in order to secure the highest percentage of clean, long fibre. The vats, available at every indigo factory, can also be utilized to work the improved process known as the "Bourghem" retting system, which has great advantages over other methods. Under this system, in which the dried stalks can also be worked, the retting process is completely under control in a series of vats in which the conditions can be regulated, thereby ensuring uniformity of production. The following

detailed description by an indigo planter of this process is of general interest :—

“ I have begun my holiday well, as you will I think agree with me, when I tell you that I have spent yesterday in studying a new process of flax retting which seems to me to offer great advantages and is likely to be a success. It is the outcome of the ideas of a practical mechanic, a Mr. Legrand of (Lille) Antwerp, and a man whose name I could not catch, but whose family from father to son have been for generations engaged in steeping and retting flax in the River Lys, and who has, I understand, been also employed in flax spinning.

“ I was allowed to see the whole installation in consequence of my connection with Indian flax-growing, as the patentees came to the conclusion that this process might be very advantageous for India, their idea being that their process will be set up in districts where flax suitable for fibre purposes can be grown.

“ Their contention is that they can produce fibre quite equal to the Courtrai steeped in the Lys and at much less cost, the Lys process being very costly from the amount of handling, etc., and liable to be interrupted from the state of the river (for instance no flax is at present being treated in the Lys, which is too much in flood) and now and again flax in process is destroyed.

“ By this new process, steeping and retting goes on all the year round and the amount of labour required is trifling, but that labour must be intelligent.

“ The installation is at a small village called Beerghem about ten minutes by rail from Bruges, or say, half an hour from Ostend. It was started in November last year and up to now 400–500,000 kilos of flax straw have been treated, say 4–500 tons. The installation is set up on the side of a small stream, a mere ‘burn’ over which you could stride or certainly jump, of sluggish running, not over-clean looking water, probably yesterday with a depth of a foot to a foot and a half, but falling in summer to an inch or two. (I give these details to show that no great volume of water is necessary in this process.)

“ The installation consists of a range of light brick buildings, the central feature of which is a long hall containing or rather consisting of a long tank divided into five sections and with a factory along the side. Over these tanks is a sort of travelling crane. In No. 1 tank, next the door, the process begins. The tank is filled with water which has been taken from the ‘burn,’ and first of all passed through a filtering pit from which it is pumped into the tanks by a system of connecting pipes, by an engine which supplies the power for the whole installation. The water in No. 1 tank is heated to a temperature of 30–31 degrees centigrade (86–88 degrees Fahrenheit) and into this water which is pure and has no chemicals whatever, the flax, which is put up in small sheaves and placed in crates standing on its end, is placed or plunged until it is quite submerged and is kept down by a very simple arrangement. Each tank holds three of these crates of flax and the crates are lifted from the trolley by the travelling crane and dropped into the tanks. In the first tank, the flax remains for one day, during which, however, it is lifted in the crate by the travelling crane and held over the tank a few minutes to allow the water to drip through the sheaves, two or three times in the day and then replunged into the tank so that the water rises right through the sheaves, so that you may say every straw gets the full benefit and the steeping is pretty even all through the crate of flax. You see the gums rising in a scum to the surface of the tank and the

stand is horrible. After a day in No. 1 tank, the crates are lifted into No. 3, and remain there, with these occasional liftings, until the retting process is complete. This takes from 2½ days with poor straw up to 3½ to 4 days *outside* for heavy good straw. The process has to be watched *carefully*, in fact day and night, and the flax lifted from the steep just at the right time, when the process of retting is complete, but *two men* are all that are necessary to handle the flax from the tanks. Taken from the tanks, the crates are put on trolleys and stand for a day or a couple of days *in garden*, after which the trolleys are run out on a light line of rails to a meadow, where the flax is taken out of the crates, the bundles opened, and the flax is set up in big handfuls on end, three or four of the handfuls being twisted together at the crop end to make them stand, and here it is left to dry and further *harden* for such a time as is considered necessary, depending very much on the character of the straw, and lasting 3 to 7 days, after which it is ready to be broken and scutched.

"To break it, it is passed through quite a small machine with fluted rollers and then it is worked on the usual scutching mill.

"The yield got from the straw varies from 15-16 per cent. for poor straw, up to 12-23 per cent. for good straw. One object of leaving it on the meadow so long is to give colour.

"The water in the tanks has not to be changed with each load, but of this put into it, but can be used repeatedly until it becomes too dirty and likely to affect the colour of the flax. The water is heated by steam pipes in the tanks I understand. When the water is discharged from the tanks, it flows into a pit next to the filtering pond, through which pit the pipes conveying the fresh water are led, so that by the time the fresh water reaches the steeping tanks its temperature has risen considerably, and there is less steam wasted in bringing it up to 30-31° Centigrade.

"I forgot to mention that the seed has been taken off the flax before it was put into the steep; this is done by a machine which these people have brought out, which does not destroy the fibre. I send you small samples of straw retted by the process and of the flax produced and also of dressed lint and tow, produced by a new system of hocking which Legrand has also patented, but which I won't attempt to describe to you, but by it he claims to get 12-20 per cent. more yield and to produce much better tow than by the old system of machine hocking.

"I believe, it is the very thing for Behar, and as the indigo planters have already their indigo vats, I daresay these could be utilised for the steeping tanks without any great expenditure of money. The installation at Beerghem has cost about £2,400, but a good deal has been wasted, as it was entirely experimental, which would be saved in putting down a new place now after experience has been gained."

As regards the cultivation of the plant there is no doubt that some of the lands in Behar are admirably suited to the growth of flax. In well-selected land a crop grown from imported seed attains an average height of 3 feet. The amount of seed sown per acre is 2 maunds (160 lbs.), but it is considered better by some to sow two and a half maunds (200 lbs.). Sowing thickly on strong land is said to produce a higher percentage of fibre,

for a number of thin stems having the weight of one thick one will have a greater surface and consequently more fibre. The land requires careful preparation. It should be ploughed to a depth of ten to twelve inches, and then carefully worked so as to secure a firm seed bed and a fine surface. Careful broadcast sowing by hand produces a more uniform thick crop than sowing in drills. Some of the best foreign varieties of seed are under trial at the Pusa Experimental Station. It has yet to be ascertained whether the seed will maintain its quality with acclimatization or whether it will be necessary to import fresh seed at regular intervals. It is well known that linseed cannot be grown continuously on the same land, which becomes "flax-sick." In Belgium, the rotation is as long as a five or seven years' course.

If grown in this way, experience shows that there is as much fibre in the plant grown in India as at home, namely, about 20 per cent. of dried straw. The average yield of retted and dried straw at Dooriah from sowing at the rate of 2 maunds of seed, was 40 maunds per acre, and the percentage of fibre obtained from the straw was 15 per cent. or 6 maunds of fibre per acre. This should have given $4\frac{1}{2}$ maunds good fibre and $1\frac{1}{2}$ maund of tow, that is to say the proportion of good fibre to tow should have been as 3 to 1, but in point of fact it was only half good fibre and half tow. This defect was due to a want of skilfulness in manufacture. This point has an important bearing on the whole question, for the total money value of the yield depends very greatly upon skilful manufacture in order to create a good quality of flax with a low proportion of tow. The flax from the first year's experiments fetched £30 a ton, the second year £35, and this year it is expected to fetch £40 a ton owing to its better quality. The price of tow was about £10 a ton. The cost of production including cultivation, seed, manufacture, shipping, insurance, and other outlay expenditure, amounts to Rs. 62 per acre. Taking the 6 maunds of fibre to have sold at £25 a ton including tow, equal to say Rs. 13 per maund, we have a gross return of Rs. 78 per acre and a profit of Rs. 16.

This figure would appear to justify a continuation of the experiments and a moderate increase in the area under cultivation. Indeed Mr. Cameron, the manager, has stated that the experiments have paid almost from the beginning. It is, however, to be observed that the process of flax manufacture is a difficult one, involving a large amount of expert knowledge. It is evident from what was to be seen at Dooriah and from the figures supplied by the manager that the reason for such a low profit as Rs. 16 per acre is want of skilful manufacture. The question of cultivation can well be left to the planter and the native cultivators, for it has been

found that the plant can be grown satisfactorily. But the process of manufacture, that is to say the retting, the 'breaking' and 'scutching,' the assortment and packing for the market, cannot be performed properly by unskilled labour, and the difference between success or failure lies almost entirely in these operations. It is as cheap to manufacture well as badly, but the difference in the value of the results is very great. Badly made fibre will fetch only £25 to £30 a ton : well made fibre from £50 to £60. At the latter price the profit of Rs. 16 per acre would become Rs. 70 to Rs. 80, reckoning $4\frac{1}{2}$ maunds of good quality fibre out of the 6 maunds per acre.

Reviewing the results of these experiments and those of the past 100 years, at what conclusion are we able to arrive? It would seem that flax can be grown and manufactured in India, but in order to make it a commercial success, the complicated and technical nature of the manufacturing process should not be left to amateurs, and the employment of instructors in the manufacture of the fibre is called for. We find the experiments of to-day giving as great a promise as those of the past hundred years; we find too in 1859 that Dr. Jameson, who so successfully carried on his experiments in the N.-W. P., wrote as follows :—"All that is required to market a useful crop in India are some good Instructors to show how the fibre is to be prepared and fitted for the market, and good seed and machinery. To encourage flax cultivation in Ireland, the Home Government annually allow the Royal Flax Society Rs. 10,000, and by this society upwards of £10,000 has been spent in twelve years in salaries to instructors, &c. If, therefore, the cultivators and preparers of flax in Ireland, where all the finest kinds of machinery are available, require instructors, how much more so is it necessary that means be adopted by the Indian Government to procure some expert Europeans from Europe to teach natives how to prepare fibre. Until this is done, it is in my opinion a useless waste of money to attempt to carry on the process with success but the experiment which was then going on so successfully, has been relinquished at the very time when it ought to have been prosecuted with renewed vigour."

History is again repeating itself in regard to the first portion of this statement. It would seem that the results of all these experiments, if they do not call for large undertakings, certainly engender the belief that the culture of flax in India would be a success if only instructors were on the spot to teach the skilful handling of the fibre, which seems to be the most important of all the conditions of success, and yet appears never to have been attempted on a reasonable scale. It should be observed also that the prospects of success now are greater than they were in those days. The demand for fibre all over the world has increased enormously, and the prices of to-day are

in every way more promising. There are two separate but closely connected problems for investigation : *first*, the possibility of establishing a new industry for the growth of flax as a fibre crop for the production of high-grade fibre alone ; *second*, the possibility of introducing a system whereby fibre, probably of a lower quality, could be produced in combination with the existing large cultivation of linseed for oilseeds. The account given above shows that the first problem is being investigated in Behar ; the second problem has already received some attention at the Manjri (Poona) Government Farm, but without definite results. A more promising field for such trials is the Saugor-Nerbudda territory of the Central Provinces, where linseed naturally grows luxuriantly with a considerable length of stalk, much better than in the Bombay Deccan.

THE BENEFITS OF SHEEP DIPPING.

By CAPTAIN F. S. H. BALDREY, F.R.C.S., F.R.S.,

Fellow, Roy. Inst. Pub. Health.

Captain, C. V. D., Professor, School. Surgen., Lahore Vety. College.

DURING some twelve months' laboratory work in India, the enormous amount and serious nature of external parasitic disease amongst cattle and sheep have been very forcibly thrust upon me. I propose to give a short account of these affections as I have seen them, not from a professional and scientific point of view, which would be out of place in a journal of this nature, but from an industrial aspect in their relationship to agriculture.

I have found in the specimens of wool from sheep examined by me almost every known parasite that affects the skin of this animal. The commonest are, of course, the many varieties of ticks. There is the common red tick of the family *Ixodidae*, its species being found in dogs, horses, cattle and other animals. It is characterised by its colour, the presence of a scutum (that is a small hard shell of a darker red colour, present on the superior and anterior surface), and its habit of remaining upon the one host from its larval stage until its full maturity, when it falls off to lay its eggs. It is a species of this tick (*Boophilus Australis*), which is most common in this country and which is the intermediary host of the disease known as Tick Fever, Texas Fever, or Red Water. This disease is indigenous in India, and is constantly demonstrated in the blood in the form of piroplasma, *i.e.*, a protozoon organism which attacks and enters the red corpuscles, either in the small variety first noticed by Lingard and called the *Piroplasma Tropica*, or in the ordinary form of *Piroplasma Bimminum*, first noticed in this country by Raymond.

Another variety of tick, which has, I believe, not been before recognized in this country, is one of the species of *Argasidae* of the family *Ixodidae*, which is characterised by the absence of the scutum already described. They appear at first sight to be more like a wood louse in size and habit of movement, are grey in colour, and do not live permanently on the one host, *i.e.*, they will fall off and hide in a crevice of a wall and attack another

animal the next day or night. They are more nearly associated with fowls, and are the intermediary hosts of a disease of these birds known as *Spirillosis*. Theiller, in South Africa, has recently shown that they also convey a spirillum which affects cattle. The spirillum is an organism having powers of movement, which gains entrance to the blood-stream, but not into the corpuscular elements, causing fever, anæmia and death. It is a tick of this class which is associated with the disease known in the Punjab as *Chicheeri ke bimari*, now being investigated at the Lahore Veterinary College. The variety and number of species of ticks of both the above big orders are very great, much investigation being required before we can expect to know and identify all of them. In view, however, of their great importance in the transmission of disease, this knowledge is absolutely essential.

Another common affection of the sheep is the presence of lice, the species found by me being *Hematopinus* and *Trichodialis* of the family *Pediculæ*. I have seen sheep literally covered with these parasites, and it is said by the natives that they cause death. From some of the cases that I have examined, this would seem to be quite possible, the wool and hides being so packed with lice that the irritation of their presence and the amount of blood sucked by them from their host would be sufficient to induce this result. The natives call this disease *Juvee*, signifying lice. It is supposed to induce diarrhœa and death, but I have found that the cause of death is *Coccidiosis* or *Psoraspormosis* which is an altogether different disease, although it is not known but what lice may have something to do with the infection as an intermediary host.

Ringworm seems to be more or less common also. The Superintendent, Civil Veterinary Department, Punjab, lately sent me some wool from an outbreak of what was supposed to be sheep scab, which was entirely ringworm of the *Tricophyton tonsurans* variety, almost every hair being affected. This is an affection, requiring much trouble to eradicate, and the loss is very considerable both in the lives of the sheep, and in the condition of the mutton and the fleece.

Finally there is ordinary sheep scab, due to the *Acarus* of that disease, (*Sarcoptes scabiei oris*), which is also more than ordinarily common in sheep, and a similar condition prevails in Buffaloes. It is looked upon by the native owner as an act of God for which there is no remedy. Imagine this condition in England or in any country where the raising of stock is conducted on modern principles.

I have given the above instances of disease in order to show the necessity for the recommendation which I wish to make for the introduction of the practice of sheep-dipping. It is a curious fact that the market prices of

most agricultural products of India are invariably lower than those of any other country. The prices of hides and wool are very poor as compared with Australia and America, and this seems mainly due to the careless condition of production in this country. The wool sent out is invariably the dirtiest in the market, the hides are badly saved, tick-eaten and inferior. All this is due to the indifference manifested in their preparation. As far as I can gather such a thing as a sheep dip has never been heard of, the ordinary precaution of having sheep dipped before the wool "clip" not even being thought of. This may possibly be due to the apathy which is characteristic of the country, but the want of any standard of excellence as an example has also a great deal to do with it. The reasons why India is not a much better stock raising country should be carefully considered. In comparison with other stock raising countries, the climatic conditions are not greatly worse in India. I have grilled in a tin-roofed hut in Queensland where it was necessary to allow 10—12 acres for each bullock and 6—8 acres for each sheep. Years ago I was stock riding in a similar country in the U. S. A., *viz.*, Arizona, where the summer heat is as trying as India, and feed is at times as scarce. But still these places are capable of producing meat, hides and wool of the first quality. A great deal of this inferiority of Indian products is due to the parasitic affections which are so exceedingly common amongst sheep, cattle and buffaloes. It is easy to imagine what deleterious effects the presence of these skin affections has not only upon the hides and wool, but also upon the animals themselves. The irritation set up inhibits the possibility of good condition, and the blood sucked is a serious debilitating loss, rendering the animal the more liable to attack by any contagious disease that may be prevalent at the time, especially as each bite of a parasitic insect causes a wound through which pathogenic organisms may gain admission.

There may be other factors which militate against a successful stock raising industry, such as the curtailment of grazing areas by the increase of cultivation. Such questions have been raised from time to time, but do not concern the point to which I wish now to draw attention. In fact, cultivation may have a beneficial effect on stock raising; in the Argentine, huge tracts of alfalfa (lucerne) are put down for the grazing on most of the cattle and sheep runs, and in New Zealand artificial grazing of the very best quality has been introduced into the previously barren volcanic country by the sowing of clover.

As a means of reducing the ill effects of the above-mentioned parasitic affections, a system of clipping and regular dipping would appear to be indicated, whereby the external parasite would be removed, and some

of the diseases which they convey would be lessened. If only a few sheep were saved to each breeder in each year, an enormous surplus of stock would be gained, sufficient to provide all the Army Rations and other varieties of tinned mutton that are so extensively used in this country, not to mention the benefit accruing to the wool clip. This again suggests the possibility of establishing canning factories, and the increased trade which the industry would induce.

Indian stock-raisers are not as a rule big owners ; they each possess comparatively few animals which all receive almost individual attention, being watched while grazing and under care at night. This would facilitate the introduction of a system of regular clipping and dipping. It would be easier to have animals clipped and dipped than is the case in the huge herds of eighty to a hundred thousand animals, as they exist in the Colonies and the Argentine ; and yet in these latter countries the thing is done without difficulty, although labour is at a very high premium. The practical application would not be difficult : a dipping place could be arranged for amongst every two or more villages, where dipping could be carried out under trained supervision at regular intervals, as indicated and advised by Veterinary Superintendents. If necessary, a small fee might be charged to the owners in order to cover the expenses of the dip used, but for each individual sheep this would be infinitesimal, and would be paid for many times over from the benefits received. The inauguration of such a system would require the institution of some practical authority on the lines of the Stock Departments in Australia, or the Bureau of Animal Industry in the United States of America or the Agricultural Department in South Africa. A number of practical travelling Superintendents with expert veterinary knowledge would be required who could get quickly from place to place and see in what way the bad conditions which I have indicated could be ameliorated.

The chemical constituents used in the making of sheep dips and the method of mixing them in their proper proportions are hardly questions for this paper, but a system of dipping being now a recognized institution in most civilized countries, no difficulty would be experienced in obtaining full particulars as to the methods and their practical adaptation.

MANURIAL EXPERIMENTS WITH WHEAT AT THE NAGPUR EXPERIMENTAL FARM

By D. CLOUSTON, *use.*

Deputy Director of Agriculture, C. P.

ABOUT the middle of last century Agricultural Science was only just beginning to investigate many of the most important questions relating to plant-nutrition and soil-chemistry. Thanks to careful experiment and scientific enquiry, much of that investigation has long since passed beyond the pale of mere theory, and has become part of a more or less exact science—the science of agriculture. The knowledge so obtained has become the foundation on which the principles of our best farm-practice of the present day are based. Only sixty years ago, however, our men of science had but touched the fringe of many of these great questions.

Liebig's Mineral Theory.—About that time, for instance, we find Liebig investigating the problem as to what really are the essential ingredients of plant food, and after much careful and laborious work in pot-cultures and soil-analyses, we find him expounding to the world his “Mineral Theory,” that if you supply a plant with these mineral constituents found in its ash, as shown by its analysis, it will grow luxuriantly, because the air and soil together supply it with a sufficiency of carbon and nitrogen. He seemed to think that the ammonia of the air was an unfailing source of nitrogen, while in addition to this the plant has at its disposal the ammonia given off by decomposing vegetable matter.

M. Georges Ville.—Ville, though of the Liebig school, attached more importance to the need of supplying nitrogen to the growing plant. He includes it in what he calls his “Normal Manures,” along with phosphoric acid, lime and potash; and states that, after much careful investigation into the results of his pot-cultures, he had arrived at the conclusion “that by the aid

of these four simple chemical products a maximum crop may be obtained from all plants in any place and in any condition of soil; further that by varying the quantity of these products, the work of vegetation may be regulated almost like a machine, the usefulness of which is in proportion to the fuel consumed." Ville's theory then reduces itself to this, that to fit a soil for growing a crop you should see that these four essential constituents are there in sufficient quantity. Should it be deficient in any one of them, then that one should be applied as a chemical manure. But here a difficulty arises, for he had repeatedly found that soil-analyses were of little practical value. "Of what use is it to us to know that the soil contains phosphoric acid, potash, nitrogen, etc., if we consider active and inactive parts in the light of a loose and heterogeneous mass, as given in an ordinary analysis? No matter how exact in its details an analysis of the soil may be, it remains a dead letter with respect to the needs of plants, seeing that their roots are not provided with either acids, alkalies, or any other means of decomposing compounds, such as the chemist has at his disposal;" in other words the chemist at that time had not yet learned how to discriminate between the plant food which was immediately available in the soil, and that which only became available when treated with the strong acid solvents which he used in his analysis.

Ville's practical method of Soil Analysis.—Acting on the assumption that it was possible to bring the most barren soil to the highest degree of fertility by adding one or more of the four essential constituents, Ville devised a method for finding out which of these four are deficient in any one particular soil, and for any one particular crop. His was a thoroughly practical method of analysis. Five adjacent plots of equal area were chosen in the area to be considered. To the first plot no manure was applied; to the second he applied the complete manure, *i.e.*, nitrogen, phosphates, potash and lime; while from the remaining three plots, one of the four manures was withheld in turn—only three being applied to each. The plots were all sown with the same crop. A typical experiment tried by Ville with wheat gave the following results:—

No Manure.	Complete Manure.	Minus Nitrogen.	Minus Phosphate.	Minus Potash.	Minus Lime.
720 lbs.	2,580 lbs.	840 lbs.	1,590 lbs.	1,560 lbs.	2,460 lbs.

From these results the following deductions can be made (i) that the soil requires above all a nitrogenous manure; (ii) that it is deficient in

potash and still more in phosphates; but (iii) that it already contains about enough lime for this special crop at least. In manuring such a soil for wheat, lime would be omitted altogether, but a heavy dose of some nitrogenous manure, along with a more moderate supply of phosphates and potash, would be necessary.

Experiments at Nagpur Farm. Experiments of a similar character were initiated at the Nagpur Farm in the year 1883 by Mr. (now Sir Bamfylde) Fuller, who was Director of Agriculture at that time. They were continued for ten years with the one crop—wheat. During the first five years wheat was grown as a dry crop without irrigation, but the area was then changed and one to two waterings were given each season to the crop grown on the new area. The experiments may, then, be divided into two series. They were carried out with the greatest care, and the results obtained were proportionately valuable.

The aim of the investigation was to supply a much felt want, viz., some definite information as to the fertility of "black cotton soil" for wheat. It was generally supposed to be rich, but whether in all, or only in some of the four essential constituents of plant food, no one then knew. It had been suggested that its fertility, like that of other Indian soils, might be due to a large amount of nitrogen obtained as ammonia in the rainfall. As recently as 1892, we find Dr. Voelcker hazarding the opinion that the soil of the Central Provinces did not require manure, and that that of the Nagpur Farm was too rich for experimental purposes. It is only fair to say that Dr. Voelcker had not had the opportunity of analysing samples of its soil; nor, indeed, would any analysis have given much accurate or practical information as to its fertility at the stage which soil analysis had reached at that time. The Ville experiments of the farm were thus designed to solve a problem of a most practical and scientific nature—a problem, too, which up to that time had not received half the attention its importance deserved.

First Series of Experiments.—The first series of experiments dates from 1884 to 1889. The results of 1887 I omit, as the plots were overflooded that year, washing the highly soluble manures used from one plot to another, and giving results so discrepant that no deductions of any value can be made from that year's outturn. The fertilizers were employed in the following proportions per acre:—140 lbs. of ammonia chloride, 180 lbs. of superphosphate, 90 lbs. of sulphate of potash and 100 lbs. sulphate of lime. Their purity is not recorded, but the quantities used were supposed to be equal in amount to what a 1,260 lbs. crop of wheat per acre would make use of. The arrangement of the plots and the yield of grain in pounds per acre

during the first four years were as given below. The plots were each 1 20 of an acre in size—

Series I unirrigated.		Plot I	II	III	IV	V	VI
YEAR.		Complete Manure.	Phosphate omitted.	Nitrogen omitted.	No. Manure.	Potash omitted.	Lime omitted.
1883-4	...	2,000	1,780	1,170	780	1,460	1,560
1884-5	...	1,380	1,465	920	735	1,270	1,320
1885-6	...	940	1,130	1,040	695	725	1,065
1888-9	...	810	630	690	690	560	590
Average	...	1,283	1,251	955	725	1,004	1,134

Manurial results dependent on (i) Rainfall, (ii) Rust.—In examining these results what strikes one first is their marked irregularity from year to year in spite of the fact that the plots have had the same manurial treatment. Taking the unmanured plot as our standard, we find that the outturn in grain per acre of Plot I, with the complete manure, is nearly three times that of the standard plot in 1884, while in 1889, the fourth year of the series, it only exceeds it by a fifth or less. While Plot IV has only varied at the rate of 90 lbs. per acre, the variation in Plot I is actually at the rate of 1,220 lbs. In examining the meteorological conditions of the two years, we find that the abundant and regular rainfall of 1883-4 explains the bumper crops of that year. The manures applied were all dissolved and thus made available for the growing crop. In the fourth year owing to the lack of rain in September and October, followed by its complete failure during the winter months, all the plots germinated badly, while the manured ones could make but little use of the fertilizers which lay dry and powdery in an equally dry soil. Plot IV, depending as it did on its natural fertility, had less to lose, as the results clearly show.

Rust is another factor that goes far to mar the success that would, otherwise, attend the application of fertilizers to the wheat crop. In the third year of the series, for example, the heavy rains and cloudy weather of December and January brought on a virulent attack of rust, which reduced very much the gain from the use of manure in that year, while the unmanured plot suffered comparatively little. It seems that the more succulent crop forced up by manures is both a more attractive host-plant for this parasitic fungus, and also the crop being so much denser catches up far more of the wind-carried uredospores, than does a more straggling crop.

Deductions made from average outturns.—In spite of this irregularity in the results from year to year, due to the causes just explained, still,

taking the averages for the four years, we have sufficient data for broad and accurate conclusions. In the first place an average of only 725 lbs. or 12 bushels per acre from the unmanured plot, is, to put it mildly, certainly no indication of a naturally rich soil : while the average increase of 557 lbs. or nearly 10 bushels got from Plot I is ample proof of the fact that the soil was originally lacking in fertility, and was for that reason very responsive to the application of the fertilizers. In other words Plot IV, which represents fairly well the natural fertility of the "black cotton soil" of the Nagpur country, is decidedly deficient in one or more of the four essential constituents of plant food.

Taking next the averages for Plots I, III, and IV, we notice that nitrogen accounts for an increase of no less than 328 lbs. over the unmanured plot. When it is added, Plot I yields 1,283 lbs., but when it is withheld, as in Plot III, the yields falls to 955 lbs. While nitrogen alone has been beneficial to the extent of an additional 328 lbs. of grain, the combined increase reaped from the other three, *viz.*, phosphates, potash and lime, only amounts to 230 lbs. Our second deduction then is that in the case of this particular soil, nitrogen is by far the most deficient constituent of plant food, and should, therefore, form the basis of every manurial dressing applied to wheat on such a soil.

The nitrogenous manure more effective on irrigated land.—If we now compare series (I) which was unirrigated, with series (II) the plots of which received one to two waterings each year, we note that under irrigation nitrogen is comparatively even more effective ; for while the three mineral fertilizers raise the outturn by only 11 lbs., the nitrogen of the ammonium chloride accounts for a gain of 413 lbs., as seen below—

Series II irrigated.	Plot I.	II.	III.	IV.	V.	VI.
	Complete Manure.	Phosphate omitted.	Nitrogen omitted.	No Manure.	Potash omitted.	Lime omitted.
1890-91 ...	1,435	1,270	805	765	1,455	1,270
1891-92 ...	1,230	1,500	710	710	1,440	1,240
1892-93 ...	480	325	105	130	335	415
1893-94 ...	786	790	430	374	686	782
1894-95 ...	652	870	465	482	740	735
Averages	916	953	503	492	955	888

The one or two waterings were sufficient to dissolve the ammonium chloride, and in this state it was available to the growing crop, in spite of the conditions of drought which prevailed during the *rabi* season in 1893. That the average outturns of series II are nevertheless lower than those of series

1 is due (*a*) to the crops of 1891, 1893 and 1894 being attacked by rust, and (*b*) to the fact that the field chosen as the site for these experiments had received no manure for the six years previous to its selection for this purpose. These two causes combined will explain the low average yield of 492 lbs. got from the unmanured plot.

Results given by the three mineral manures.—While the results of both series show a great uniformity in the splendid results given by all the plots to which nitrogen was given, we find those given by the mineral manures used are so erratic that no very definite conclusions as to their comparative merits can be drawn from them. At first sight one is apt to argue from the figures of Plot III of series II, that these three mineral foods are not deficient seeing that when all were applied and watered on that plot, they only raised the outturn by 11 lbs. over the unmanured plot. But this line of argument may manifestly prove to be fallacious, for as that plot had no nitrogen applied to it, it suffered from nitrogen starvation, and no matter how much other soluble plant food is added, the crop can make no use of it so long as there is no available nitrogen. Just as in the feeding of animals very much depends on the proportion between the nitrogenous and non-nitrogenous digestible constituents of food, and just as that ratio varies considerably for the different kinds of livestock, so the healthy growth of any one crop is determined by the "nutrient ratios" of the essential food constituents with which the soil is supplied. Hence the productiveness of a soil comes to depend entirely on that essential food which is present in the least proportion. Though Plot III has been abundantly supplied with phosphate, potash and lime, these are of no avail so long as no definite proportion of nitrogen is applied along with them.

To estimate the relative values of these three mineral fertilizers we must see how the absence of each in turn affects the outturn. Taking first the average for Plot II of each series, we find that the effect produced by withholding superphosphate from the manure applied gives no definite results in favour of the use of that salt. No. II dry plot suffered an average loss of only 31 lbs. when it is omitted, while the wet plot actually did better without it. Phosphoric acid is evidently present in the soil of the Nagpur Farm in sufficient abundance to meet the requirements of any such cereal crop as wheat. This is not what one with a knowledge of western agriculture would have anticipated. British and American agriculturists who use chemical manures for wheat generally find that it pays to use phosphate in some form along with some nitrogenous manure. The fact that the ash of wheat grain contains 46 per cent. of phosphoric acid points to its importance for this crop. Comparing the averages of Plots V and VI with Plot I in both

series, it will be seen that while on the dry plot it is potash, on the wet plot it is the calcium sulphate that is the more beneficial; on the whole the results will not justify the assumption that either is actually deficient in our "black cotton soil." Had they been deficient, then they should have exerted their full force on the wet plots to which they were applied; but instead of that, the plot without potash gave on an average a better crop than did the complete manure on Plot I, while the average for the plot from which lime was withheld has suffered very little.

If the soil is not actually lacking in potash and lime, how then can we account for the fact that they have given an average increase of 278 and 148 lbs. respectively per acre on the dry plots? This may be due to either of two reasons, or more probably partly to both. They may have some small effect in forcing on the crop in virtue of the fact that they supply it with a very soluble and immediately available supply of plant food at the critical time at which it is most required. This is quite in keeping with our assumption that there was no pronounced lack of either to start with. But a second and more probable explanation of the results may be that the increases produced by these two manures are not so much due to their intrinsic values as plant food, as to their chemical effect in increasing the supply of nitrates in the dry soil; for nitrogen is apparently the one ingredient which regulates the fertility of this particular soil. The saltish nature of the potassium sulphate, more especially, would to a small extent at least act as a solvent on the ammonium chloride.

Chemical and practical analysis compared.—Let us now compare the practical analysis with an up-to-date chemical one. In 1896 Dr. Leather made the four following analyses of soil from the Nagpur Experimental Farm :—

	Plot A-4 increased with 6 tons of sulfate manure per acre per annum.		Plot A-5 increased with green manure ploughed in annually.		Plot A-7, no manure.		Totals, means.	
	Surface soil.	Sub soil.	Surface soil.	Sub soil.	Surface soil.	Sub soil.	Surface soil.	Sub soil.
	Z.	Z.	Z.	Z.	Surface soil.	Sub soil.	Surface soil.	Sub soil.
Total Nitrogen	005	033	015	033	006	017	009	017
Total Phosphoric Acid	0001	005	078	008	001	004	006	013
Available Phosphoric Acid	020	008	018	004	007	005	—	—
Potash	—	—	—	—	—	—	—	—
Available Potash	021	010	010	010	012	010	182	176
Lime	—	—	—	—	—	—	—	—

These are, as far as I know, the only analyses available. Three of them are not very suitable for our purpose, seeing that they were taken from a series of continuous wheat experiments which had at that time been in progress for eleven years, so that in the case of the unmanured plot at least, the analysis represents the unexhausted fertility of the soil after eleven years' continuous cropping without manure. From the figures given we can calculate, though very roughly, what the initial fertility of that soil must have been.

Nitrogen.—In the first place we note that the total nitrogen is very low in all the plots. An average soil in England will contain about 0.1 per cent. of it. Dr. Dyer found 0.099 per cent. in the unmanured plot of the Rothamsted Wheat Experiments after it had given fifty crops in succession without manure, and the Rothamsted soil was just of an ordinary type when the experiments began, and certainly not richer in dormant plant food than the majority of heavy English soils. Compared with that soil, our figures for nitrogen are exceptionally low. After having its resources drained for fifty years, the Rothamsted soil still contains a half more total nitrogen than our "black cotton soil," which even as in plot A-6 has been fed up for eleven years at the rate of 6 tons of cattledung per acre; and it contains more than twice as much as our plot which had been continuously green-soiled for that time. That the total nitrogen in the green-soiled plot should be less than it is either in the unmanured or in the typical soil sample is, I confess, a great mystery to me. It would seem to point to a probable difference in the natural fertility of these plots to start with.

Lime.—Dr. Leather includes lime in only one of his analyses. His figures show that there is abundance of this ingredient. One half per cent. of lime in the first nine inches of soil is considered sufficient for arable land.

Potash.—Our chemical and practical methods of soil analysis are in complete agreement, then, as far as both the nitrogen and lime of the soil are concerned. They also agree in showing that there is a sufficiency of available potash. Dr. Dyer's method of analysis, on which Dr. Leather's was based, has shown that when an ordinary arable soil contains 0.01 per cent. of available potash and phosphoric acid respectively, in its surface layer of nine inches, it stands in no immediate need of special applications of these for cereal crops. Dr. Dyer used a one per cent. solution of citric acid as his solvent, and considered that its dissolving power on potash and phosphates represented fairly well the dissolving strength of the acid secretions of the root-hairs of an ordinary crop. In a soil the potash and phosphoric acid soluble in this solution were, therefore, considered as "available" for the

crop. In no case, it will be seen, does the available potash fall so low as this standard.

Phosphoric acid.—Looking lastly at the percentages of available phosphoric acid as given in the chemical analyses, we find what at first sight appears to point to a marked discrepancy between the two methods of analysis. The analyses of plots A-8 and A-7 show only 0.008 and 0.007 per cent. of phosphoric acid respectively. These plots, however, do not fairly represent the average initial fertility of the soil of the Nagpur Farm, but only its fertility after having undergone a gradual exhaustion of its plant food by eleven years' continuous cropping. Still these results cannot be said to corroborate thoroughly the findings of the Ville Experiments. If there had been abundance of phosphoric acid in Plots A-8 and A-7 to start with, the 7 lbs. per acre or less removed by the crop annually would not account for the low figures shown by the chemical analyses, unless the amount lost by surface wash and drainage is very much greater in Indian soils than in an average English soil. In the case of the unmanured plot in the Broadbalk field of the Rothamsted Experiments, for instance, the percentage of available phosphoric acid in that soil of only average fertility was found to be 0.0078 after it had given fifty crops of wheat in succession. If the samples analysed were typical of the soil of the Nagpur Farm, then that soil must either have contained initially less than the normal quantity of available phosphoric acid for an average soil, or if it did contain abundance, it must have lost a considerable quantity that cannot be accounted for in the crops produced. English soils suffer very little loss of phosphoric acid by drainage, but the conditions here being different, may give different results. Perhaps some fresh light may be thrown on the question by the more representative analyses of our soils which are now being carried out, including as they do not only samples from plots exhausted by a twenty years' continuous cropping, but also samples typical of the soil's initial fertility.

The geological conditions of the soil. It may be interesting now to see how our Ville Experiments harmonise with what we know of the general geological conditions of the Nagpur soil. The soil consists mainly of the debris of trap rock and reaches a depth of from five to six feet. It contains but few stones. Those that are found are commonly angular lumps of gneiss and lime stone and more nodular pieces of quartz of different degrees of purity, but generally coloured with iron. The soil when moist is dark in colour and changes to a darkish-grey on drying. The dark colour is due to the presence of certain colouring mineral matter and not to decayed vegetation as was formerly believed to be the case. What that colouring matter is

we leave to geologists to decide. The surface soil shows abundance of lime which exists in small seedlike specks in every lump of earth examined. When one of these lumps is placed in hydrochloric acid, great effervescence takes place, and on the lime being decomposed, the whole lump of earth crumbles down. The soil is fairly retentive of moisture and becomes very adhesive when wet, clinging to the sole of the boot with a putty-like persistency when one walks over it. On drying, it cracks freely to a depth of two or three feet. The immediate surface soil, too, crumbles down into a very fine tilth. Its sticky quality when wet, and its tendency to crack and pulverise when dry, are due to the presence of colloid material consisting of finely divided clay particles. These particles are coagulated by a clotting agent—carbonate of lime in this particular case. On drying, the soil cracks freely, and the surface becomes covered with an apparently coarser grained material than that of which the bulk of the soil is composed, forming a fine surface tilth. Being of a mineral origin it is deficient in organic matter, which is the chief source of a soil's nitrogen.

General conclusions—All our different methods of examination then lead to the same general conclusions, *viz.*, that our "black cotton soil" is only second class in quality, and that its great defect lies in its want of a sufficient supply of any form of nitrogen. It may be that in our tropical climate with the average temperature approaching the optimum for bacteriological action in the soil, the rapid decay of organic matter thus produced may be opposed to any accumulation of nitrogen. Undoubtedly the soil is rich in lime, too, which would facilitate the process of decomposition. To this is to be added the fact that the native cultivator is not in the habit of using manure. These three factors combined may explain the poverty-stricken state of our soil in nitrogen.

How we may most economically supply this nitrogen is evidently a question of the very greatest importance to the raiyat. Before recommending the use of highly soluble nitrogenous manures, we must prove in the first place that the cost of the manure is more than covered by the value of the increased produce, and in the second place that the soil suffers no deterioration when continuous applications are made. It was not the object of the Ville Experiments to investigate either. Attention may, however, be drawn to the apparent exhausting power of nitrogen as shown by the results of both series. Leaving out the results of the year 1892-3, which were abnormally low all round owing to a bad attack of rust, we note that with the exception of Plot II of series II, the outturns of the plot to which ammonium chloride was added, diminish faster than do those of other plots.

Taking the two series, and the initial year of each as 100, the results for successive years vary as follows:—

		I	II	III	IV	V	VI
Series I.	1883-4	100	100	100	100	100	100
	1884-5	69	82	79	94	87	81
	1885-6	47	63·5	89	80	60	68
	1888-9	40·5	35	59	88·5	48	38
	Loss	59·5	65	41	11·5	92	62
Series II.	1890-91	100	100	100	100	100	100
	1891-92	86	118	88	93	99	98
	1892-93	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted
	1893-94	55	63	53	49	42	60
	1894-95	46	68·5	58	63	51	58
	Loss	54	31·5	42	37	49	42

It may be inferred that the addition of soluble nitrogenous salts, at any rate as chloride of ammonia, as manures on "black cotton soil" in India, is fatal to the future fertility of the land, but much more evidence is required before this inference can be accepted as a fact. In the Western Hemisphere the evil effect of nitrate of soda on certain soils is recognised by the intelligent farmer. When he continues to use it for cereals he finds that he generally gets a gradually diminishing yield from its use. This he sometimes wrongly attributes to a supposed injurious chemical effect that this manure has on the soil.

The object of the Ville Experiments, however, was merely to determine in which of the essential ingredients of plant food our "black cotton soil" is deficient. Questions relating to soil-exhaustion and to the most economical forms in which to apply nitrogen as a manure, have been investigated by another series of continuous manurial experiments with wheat which have been in progress for the last twenty years. A critical examination of the results of these will form the subject of a future article which, while showing the most profitable manures that the ordinary cultivator should use for wheat, will also throw new light on the question of how that soil has been affected by the continuous application of the different manures employed.

CO-OPERATIVE CREDIT IN BENGAL.

By W. R. GOURLAY, I.C.S.,

Registrar of Co-operative Credit Societies, Bengal.

WHILE the problem of the improvement of Indian agriculture is being attacked from the experimental and the research side by the Imperial and Provincial Departments of Agriculture, the more important question of financing the agriculturist has not been forgotten. It is remarkable that the industry by which over eighty per cent. of the population live is supplied with most of its capital at a rate of interest varying from 25 to 50 per cent. per annum. Any other industry would die under such conditions, but the agricultural industry cannot die ; it is the ryot who dies. He cannot turn to a more lucrative occupation when agriculture does not pay ; he either starves or becomes hopelessly indebted and the slave of the money-lender. If the problem of financing agriculture can be solved, the benefit to the ryot will be greater and more direct than the saving occasioned by new methods of agriculture or the profit to be gained from a greater outturn. Without the use of capital at a reasonable rate, the agriculturist will be unable to take advantage of new ways and means. The success of the results of research and experiment depend directly on the success of the effort to supply the ryot with capital at a reasonable rate.

Cheap capital or facile credit is not necessarily a boon in itself. Switzerland has organised a system of cheap credit with the result that 60 per cent. of the land is now mortgaged. The present and past generation have merely discovered a system of robbing future generations of a portion of their means of livelihood. Any increase in comfort has been obtained at the expense of their children's children. If credit of this kind were supplied to India, the ryot, who formerly was in a position to borrow Rs. 100 from his mahajan for his daughter's marriage and pay 50 per cent. per annum for the accommodation, would simply spend more on the marriage, and so land himself deeper in debt. With credit cheap he would purchase more.

The question has thus two sides, commercial and economic. A system of finance which might prove a commercial success would not necessarily

prove an economic success, but the system which promises to be an economic success must be based on commercial principles. The commercial side may be shortly stated thus:—the ryot is ready to borrow a sum of money for which he is at present paying interest from 25 to 50 per cent. or more; the majority of ryots have good security to offer for the sum which they require, while the capitalist has money to lend on good security at 6 per cent. These two have to be brought together for their mutual benefit. It would be easy and commercially profitable for the State to set up an agricultural bank provided with special summary powers for collecting its dues, but such a system would not benefit the agriculturist in the long run.

It is impossible for the large capitalist to come into direct contact with the small cultivator. The capitalist has no local knowledge of the individual, he has no agency for collecting small loans, and he could not keep millions of small accounts. There must be some intermediate organisations. In Germany this has been found in Co-operative Credit Societies, and in India an attempt is being made to create a similar organisation. This system aims at capitalizing the honesty of the villages. Where anything in the shape of a village community exists, the majority of the cultivators have a character for honesty, often not extending beyond the narrow limits of the village, but within these limits most transactions take place without any written bond, the man's word being sufficient. On this honesty a certain amount of credit is based; it may be a credit of only a few rupees, but the measure is known to the villagers. They know exactly how much a man ought to spend and how much he can earn. We want, therefore, to teach the people to amalgamate this village credit and jointly borrow a sum sufficient to meet the needs of the whole village. The capitalist does not know which cultivator is good for Rs. 5 and which for Rs. 100; he does not know who requires Rs. 20 to finance him and who requires three times that sum; he does not know who is already hopelessly involved and who can repay. It is the villagers alone who have all the information. On the other hand, the capitalist can see that the whole village is good for the total sum required. The ryots take the responsibility for dividing the money, of collecting principal and interest, and of keeping the separate accounts. This organisation of credit must be the bed rock on which any system of agricultural finance is based, and wherever a village exists, it will be found that the ryot's credit in his own village is better than his credit anywhere else. The individual may have a character for honesty in his caste, but his credit in his village will be greater than his credit with his caste.

There is no doubt that in this we have the germ of a solution of this great financial problem, but the question remains how to provide against

the evils of facile credit. By organising the village and making the members jointly and severally responsible, we create a check on excessive expenditure and prevent the individual from robbing his children. The village will not lend to the individual unless they see a prospect of the money being repaid within a reasonable time and, moreover, they will not lend unless they consider the expenditure necessary. A man is not tempted to spend on display more than he can afford when he has to run the gauntlet of public opinion, and the village will not lend him more than he can repay when they realise their joint responsibility. Further, there are so many necessary uses to which the members can put the money that they will not give out money for unnecessary expenditure, and if the member turns to the money-lender again, his name is removed and the privilege of borrowing at a low rate ceases.

There are at present in Bengal 86 experimental village societies, and the majority of these show every sign of ultimate success. These pioneer societies are distributed over twenty-two of the thirty-two districts in Bengal. The capital has been raised partly from Government and Wards' Estates and partly from private sources. The societies pay from 6 to $12\frac{1}{2}$ per cent. for the money borrowed, which they lend again at from $12\frac{1}{2}$ to $18\frac{3}{4}$ per cent. The whole of the profits go to a village fund from which the original capital borrowed will be repaid, and the village will then be in a position to carry on their society with a capital of their own sufficient for all ordinary seasons. Working on these lines, steady progress has been made during the last eighteen months. Wherever a village community can be found, the scheme will succeed, but in parts of Eastern Bengal where the cultivators do not live in villages, some modification will probably be necessary. The societies have been founded in villages which are not heavily indebted, because they offer the best field for initial effort, but as soon as the neighbouring villages see the benefit, they also demand similar societies in order to pay off their debts and start afresh. At present the societies are small, with a capital of Rs. 200 to Rs. 300, which is often sufficient to finance a small village, and such little societies are the best ground for observation and experience.

Three grain banks, run on co-operative lines by a zemindar of Dacca, have attracted much public interest, and it has been recommended that such *golas* should be opened all over the Province. The question of establishing grain *golas* is one of some difficulty, and so far only two have been registered in this Province. The price of grain ruled high this year, so that those with surplus stocks were eager to sell, while those with short crops had nothing to deposit. A grain bank requires much supervision, and it seems impossible to run it in Bengal as anything but a store of food grain. The different varieties of paddy sown by the cultivators of a single village are so very numerous

that the individual cannot rely for his seed upon the general stock in a grain bank. Under such conditions the only method of raising a seed fund is to purchase the variety of seed intended for by each member, and to use the collection in the *gola* as food grain. The ryots readily use mixed grain for food, but seed grain must be specially selected and true to variety. For the following year a sufficient quantity of the stock must be sold and the next year's seed grain purchased. The surplus stock must be sold as soon as the new year's grain is harvested, for paddy deteriorates after one year. All these little transactions mean a large amount of labour, and it is difficult to get rid of the custom whereby everyone who touches the grain gets a certain percentage. For these reasons I have come to the conclusion that on the whole it is easier to found successful money societies than seed banks; the temptations are fewer and the trouble of management is not so great.

At present, however, one experiment on a large scale is being made. In the Sonthal Parganas the Deputy Commissioner has carried on a grain-lending business for some years for the benefit of the ryots of the Government Estate and the Wards' Estates under his charge. There are *golas* at four centres with a total capital of nearly 25,000 maunds of paddy. Loans were made to individual cultivators, but the business soon assumed such proportions that it got beyond the management of the Deputy Commissioner without the assistance of a special staff. The defects of the system were the difficulties of checking the accounts and the stock; the high cost of the management owing to the payments made to headmen and others for collecting the debts; and lastly, the exactions at all times of weighing and check. In consequence the rate charged was not smaller than the rate at which the ryot could borrow from the village grain dealer. Under the new rules recently drawn up, loans will in future not be made to individuals, but only to batches of ten on the joint and several bond of the whole number. If any batch chooses, it may be registered as a co-operative society. In such cases the loan will be treated as the capital of the village bank and half the interest will be credited to the village; in other cases the full interest and capital must be paid annually direct into the central *gola*. Loans to societies are repayable in four equal annual instalments commencing from the end of the third year.

Success in all these experiments will not come at once. It is necessary to be patient. Raiffesen started his first bank in 1849, a second in 1854, and it was not till nearly forty years later that the movement made rapid strides. In Bengal there are already over three score societies working on sound principles, and this tends to show that we are on the road to a successful solution of the problem of financing agriculture.

CYANOGENESIS IN PLANTS.

By J. WALTER LEATHER, PH.D., F.I.C.,

Imperial Agricultural Chemist.

OF the experiments made in the chemical laboratory, many are carried from the stage of pure science to that utilitarian platform which makes the work serve the every day use of man. Cyanogenesis in plants is a case in point, as it has to do with a certain class of compounds which are a cause of occasional poisoning of farm animals. As the subject has a direct interest to the agriculturist, I propose to try to explain the nature of these compounds.

The chemist has constantly to use difficult words of numerous syllables each, but he is not alone in this practice. Other scientists offend equally as much in this matter. But if the chemist pleads guilty to the use of long words, he can at least offer the defence that the syllables have a definite meaning. The title of this article, due to Professor Wyndham Dunstan, is more readily appreciated if its derivation is explained. This is *cyanogen* and *genesis*. The latter requires no further remark; the former does. Cyanogen itself is of no very direct importance to the subject in hand, but the word occurs, and a near "relative" or "derivative," as the chemist says, will be spoken of.

The man in the street knows something about atoms; that they are the chemist's units of matter, and that they unite together to form groups which are called molecules. He knows, for instance, that water is formed by a grouping of two atoms of hydrogen with one of oxygen. But not only do atoms group themselves together to form molecules; individual groups of atoms may come as units and form a new substance. Take the simple case of respiring into lime-water. The air from the lungs includes the carbonic acid which is formed by the vital processes, and when brought into contact with the lime in the lime-water, these two, each consisting of a group of atoms, join together to form a new compound. This substance appears as a milkiness, and is the well-known chalk. Now we are very apt to say that chalk contains carbonic acid, because we

can again obtain the latter from the chalk, and yet this mode of expression is not strictly correct. Carbonic acid is a gas, whereas chalk is a solid uniform substance. Chalk is not quicklime nor is it carbonic acid, but is a new substance formed by the union of these two substances. I have chosen a familiar example in order to draw a distinction, which is all important to a proper understanding of my subject.

There is a well-known class of substances to which the name "glucoside" has been given. They are found in the tissues of plants. Indican, amygdalin and salicin are perhaps the best known. Whatever their origin or their individual properties, they possess two in common :—(a) if they are boiled with dilute acids, they are split up and two or more new substances are formed, one of which is always a sugar ; (b) this same change may be effected by the fermentative action of an enzyme, i.e., one of the so-called unorganised ferments.* Among the other new substances which result from this splitting process, there is always one which is characteristic of the glucoside. Indican yields indigo ; amygdalin yields oil of bitter almonds. Further, there is one series of glucosides which not only yields a sugar and a compound peculiar to each member of the series, but prussic acid in addition. Prussic acid is a derivative of cyanogen, and hence these glucosides have been termed cyanogenetic glucosides, because they are the origin of prussic acid. Until recently amygdalin was alone among the known glucosides characteristic of this property. But during the last two or three years others have been found. The list includes, among others, lotasin present in *Lotus arabicus*, dhurrin in *Andropogon sorghum*, phaseolunatin in the seeds of *Phaseolus lunatus*, gynocardin in the seeds of *Gynocardia odorata*, and that of the tapioca root which has not yet been fully examined.

The point which I set out to explain to the ordinary reader is then that there is a class of substances, the cyanogenetic glucosides, found in plants from which prussic acid may be obtained under certain specified conditions. On the other hand, they do not contain prussic acid. It is this distinction which I hope that I have made clear.

Prussic acid is a well-known poison. One grain is a fatal dose in man. Obviously then these cyanogenetic compounds, some of which are now known to be present in certain crops, possess a special interest to the agriculturist. For, although the farmer does not boil toddlers with acid, if these peculiar substances are brought in contact with a suitable enzyme, the formation of prussic acid will ensue. And it so happens that with these glucosides, a suitable enzyme is generally present in the plant, not in the

* For a more complete discussion of this subject, see the article on the Study of Fermentation, Vol. I, page 68 *et seq.* of this Journal.

same cells, but in the same part of the plant. It is only necessary to crush almonds or jowari leaves or tapioca root in water, and allow the mixture to stand for a short time, in order to cause the change that I have spoken of. The mixture is then poisonous.

Another factor which in some cases is of great importance is that enzymes are destroyed by boiling water. It follows, therefore, that if a substance contains one of these glucosides and also an enzyme, in order to prevent the latter from having any effect on the former, it is only necessary to heat the material sufficiently for a short time, when all danger of the production of prussic acid will pass away.

We may now consider what is known regarding those cyanogenetic glucosides which occur in Indian crops. The first crop which we may notice is *Andropogon sorghum* (jowar, juari, cholam). This plant contains the glucoside *dhuririn*, situated principally in the leaves and stem. It is probable that as maturity approaches, the quantity of *dhuririn* decreases until it becomes negligible. It is accompanied by an enzyme, and it is only necessary to crush the plant in order to bring the two substances into contact and so cause the formation of prussic acid. The quantity of the latter depends entirely on that of the glucoside present. Usually it is only small, but occasionally it increases seriously. It is well known how poisonous sorghum fodder becomes at times. Suddenly the cattle are attacked with serious illness of which some die.

Whilst this general fact is established and the cause ascertained, the number of authentic cases in which the *poisonous* fodder has been examined are few. One such occurred near Poona in June 1904. The work bullocks at one of the Government Farms were suddenly attacked, a number became seriously ill, and two died. Some of the fodder was sent, after being partly air-dried, to the laboratory for examination. After crushing it with water and allowing it to stand overnight, 1.28 grain of prussic acid was obtained per one pound of green fodder. The same crop was examined a month later when the quantity of prussic acid obtained was .75 grain per pound. There is no doubt that fodder containing so much of the glucoside as these figures indicate is poisonous to cattle. This crop was sown in March 1904, was grown under irrigation and had reached the flowering stage, when it affected the cattle so seriously. Naturally feeding with this fodder was stopped. But the crop was allowed to grow to full maturity; it was then harvested (July 11th), fully dried, and then fed later to cattle without any harmful effects.

There are two important questions relative to *dhuririn* in jowar. Under what conditions is the glucoside formed in large quantity? In what part of

the plant is it principally situated? Regarding the first, Brunnich carried out some experiments at Melbourne *, and he found that the glucoside was present in the plant at all stages of growth, but that its quantity diminished as maturity advanced. Also it is to be noted that the crop of jowar, which was so poisonous at Poona in June 1904, was quite innocuous after maturity. My own experiments on this point up to the present are very limited. In 1904, immediately after the case of sickness occurred at Poona, two varieties of jowar, namely "*Nilva*" and "*Utavali*" obtained from Poona, were sown at Dehra Dun, together with a local variety, and each was examined at intervals during August and September. The plants in all cases contained either no *dhurain* or only nominal quantities of it. This experiment does not negative Dr. Brunnich's evidence, but it emphasises the fact that some jowar plants contain much more of the glucoside than others. In July 1904, a specimen of jowar fodder of the "*Hundi*" variety growing in the same neighbourhood as that which had done so much harm, was examined, and only .17 grain of prussic acid was obtained from it per pound. Thus whilst the quantity probably decreases as maturity approaches, the really important question is, under what conditions is *dhurain* occasionally formed in large amount in a crop of jowar, and why is the plant usually almost free from it? Regarding the second question, namely, in what part of the plant is *dhurain* principally situated, the specimen of poisonous *hundi* was not only examined as a whole, but the leaves, stalks, and inflorescence were each examined separately (after drying in the air) with the result that the leaves produced 2.5 grain, the stalks 1.1 grain, and the flower .25 grain of prussic acid per pound. The subject is, however, far from being completely understood, and I would be indebted to readers of this Journal if they would at any time send to the Agricultural Research Institute, Pusa, specimens of the fodder which are known to have been poisonous.

Lastly, it is to be noted that sun-drying the fodder does not decrease the amount of glucoside in it. On this point there is no doubt. Brunnich made a series of comparative experiments to test it, and in the laboratory of the Government of India, we have found similarly that the glucoside is not changed by this process.

Another plant common to India which contains a cyanogenetic glucoside is *Manihot utilissima*, the cassava or tapioca plant. The root of this plant has long been used as a human food, and in other countries both starch and tapioca are prepared from it. Authorities have generally recognised two

* TRANS. CHEM. SOC., 1903, p. 788.

principal varieties, the "sweet" and the "bitter"; the former has been held to be non-poisonous, the latter poisonous, and the poisonous agent is known to be prussic acid. Some authorities state that the "bitter" varieties possess red petioles, the "sweet" varieties green ones. A considerable number of varieties were examined at Poona in January 1904, when I was able to establish three facts: firstly, *none* of the varieties contained any prussic acid as such; secondly, *all* the varieties, irrespective of the colour of the petiole or other botanical features, contained a cyanogenetic glucoside, which varied much in amount; thirdly, this glucoside is associated with an enzyme which has the property of causing the splitting up of the glucoside, and the consequent formation of prussic acid. As in the case of jowar leaves, it is only necessary to crush tapioca root with water in order to bring about this change. The amount of prussic acid varied very much; from some roots 1.5 grain of prussic acid per pound of root was obtained, from others only one-tenth as much. This root has to be considered both as a human food and also as a source of starch or tapioca. It is probably not eaten in the raw state in India, but it is sliced and fried in some parts as a vegetable. Whether this cooking process is sufficient to render the root harmless is uncertain. It would probably be so if fried in clarified butter (ghee). Boiling the root is quite sufficient not only to destroy the enzyme but also to allow the glucoside to pass out into the water, for the root splits up freely. On the other hand a misconception has occurred in the minds of some. I noticed the statement in one agricultural paper that since prussic acid is volatile, it is only necessary to expose the slices to the air in order to allow this toxic ingredient to vaporise. But this is far from being the case, and tapioca root slices might be allowed to remain exposed to the air for a long period without losing any appreciable portion of this constituent. The question has also frequently been put to me whether, in the preparation of starch, there is any risk of prussic acid remaining in it. The answer is very simple. When preparing starch the root is grated, and there is no doubt of the formation of the prussic acid; but it is a soluble substance and must be carried away in the wash waters, so that the starch is ultimately quite free from it.

Besides these two crops I have obtained prussic acid from Rangoon Beans* (*Phaseolus lunatus*) and Val (*Dolichos lablab*) by simply allowing the crushed seeds to remain in cold water for a few hours. In the case of seeds their poisonous properties may be destroyed by boiling them in water.

* See Agricultural Ledger No. 2 of 1905, which contains an account of Prof. Dunstan's investigations.

It is also known that the linseed plant (*Linum catharticum*) possesses at times poisonous properties like sorghum, but cases of poisoning from this cause are rare. Whilst writing this article an instance of this has been brought to my notice by the Director of Agriculture, U. P. Some cattle belonging to a zemindar in the Banda District ate some immature linseed as fodder, with the result that fifty-two died in a few hours. The specimen of the plant which was sent to me contained a cyanogenetic glucoside and yielded prussic acid when crushed in water. I obtained 1.4 grain of the acid per one pound of the plant.

THE PRODUCTION OF EARLY-MATURING CANES.

By C. A. BARBER, M.A., F.L.S.,

Government Botanist, Madras.

SHORTLY after starting the Samalkota Sugar Station, a difficulty was experienced in dealing with the packages of canes received from various parts of the country when the local planting season had passed and no land was ready for their reception. Various methods of 'hatching' were tried, by which the canes, whole or cut up, were placed in shallow pits and covered up, but these did not satisfactorily overcome the difficulty and were found to give uncertain results in the soil of the Godavari delta especially after a long journey. A small nursery was, therefore, rapidly got into order and, following the method adopted in Ganjam, the sets were at once planted thickly as is done in paddy seed-beds. This method was perfectly successful, and the canes suffered in no way on being taken out and transplanted to the lands prepared for them.

About the same time attention was drawn to the Kistna delta, where, with excellent soil and an abundant irrigation from canals, no sugarcane at all is planted. While in the Godavari delta, however, irrigation is carried on for eleven months out of the twelve, the water is only available in the Kistna delta for nine months. If by some means we could reduce the period of growth of the canes to nine months, many thousands of acres would be available for this valuable crop. The way to this appeared to be opened by the nursery experiment above mentioned.

These facts led to the study on the farm of various methods of producing early-maturing canes. Although the work is still in its infancy, and exact analyses have not been accumulated in sufficient quantity to demonstrate every point, enough material has been collected to make it desirable to draw the attention of workers to this line of experiment. It is hoped especially that cane growers living in regions of limited irrigation may take the matter up and make further experiments not possible in rich delta lands.

The nursery method of propagation has been introduced successfully into various parts of the Madras Presidency. By it we were able last year

on the Samalkota farm to plant up thirteen times the area of the seed-bed and, while this cannot be done in all cases, it is evident that the land to be finally planted may be many times as large as the nursery. It is frequently possible to set aside an acre of land under a well close to the village site and plant this at a time when general agricultural operations are out of the question. Such an area would furnish seed cane for quite a large field, and the period of water scarcity could thus be bridged over from one season of irrigation or rainfall to another.

In the latest experiment on the farm, the seed-bed was planted on the 29th March 1905, and the young canes were transplanted on the 4th of June. The canes were analysed once a fortnight from the beginning of December until the harvest. They were judged to be ripe eight months after the time of transplanting. Compared with similar plots planted with sets from the beginning, the length of time from planting to reaping was the same. The period of growth in the field, saved by the experiment, was therefore exactly equal to the time spent in the nursery. We cannot say whether this would always be the case, and it is at least doubtful whether the crop would be as good as in ordinary planting,—probably not. Comparative experiments have still to be made on the subject, but there are some indications that the produce of seed-bed canes has a certain resemblance to ratoons or second-year canes.

The importance of this method of planting canes cannot be over-rated in places where the period of irrigation is short, or where the exact date of the advent of seasonal rains cannot be foretold. There is no longer any need for keeping the cane standing in the field (standovers) month after month, in the hope of rain coming. The cane sets may be cut at the time of harvest and immediately planted in a nursery, the land intended for the crop may be prepared in a more leisurely manner and the canes transplanted when it is ready and when the danger of a water famine has been averted.*

"Stool-planting" is another method adopted at the Samalkota farm. After the canes are cut, the "roots" (more properly called stools) have to be removed for the preparation of the land for the succeeding crop. If these stools are cut up they may be planted without danger. Supposing the canes were originally planted at the rate of 10,000 to the acre, the stools therefrom may be made to plant up five times the area. For it has been found in trials on the farm that, owing to the variable and rapid growth of all the divided stools, they may be economically put in at the rate of 5,000 to the acre, and that each stool will provide at least two or three plants.

* Some other advantages of a nursery may be noticed. Many of the old, common canes can be eliminated; and a more uniform stock of canes later is obtained.—*Editor.*

By this method of stool-planting the period of water scarcity can also be partially bridged. If the canes are cut in the ordinary course, the stumps will remain in the ground for a considerable time without dying and thus a part of the time of short water may be passed. Moreover, the stools mature earlier than plant canes, so that their period in the ground is shorter. The exact advantages of this method of cane-planting have not been fully worked out, and will probably vary a good deal in different parts of the country. One of the greatest is that, with proper care, no filling up of blanks will be needed. A full stand can be obtained at the start, a very important matter in successful cane cultivation. The plots planted in this way resemble ratoons even more than those planted from seed-beds, and the yield is probably less than from plant canes. On the other hand, the old roots are utilised as seed, and the canes are far more healthy than ratoons. The plants are not so long a time in the ground, as stool-planted plots ripen earlier than those planted from sets. This agrees with the well-known character of ratoons which, in the Godavari district, mature one month earlier than plant canes.

"Thashing" or stripping the canes of their dead leaves, so frequently done in moist lands in the West Indies, was tried on the farm, and the canes in one experiment ripened a month earlier than in the control plot treated in the ordinary way. The experiment is isolated and therefore not conclusive, but the result is in the direction that would naturally be expected. More experience is necessary before the method can be recommended under Indian conditions. Its usefulness will probably vary in different tracts, and where the canes are liable to be attacked by jackals or where the atmosphere is very hot, it is less likely to be advantageous. To take the case of the Godavari delta, the canes are heavily wrapped round with their own dead and dying leaves to bamboos and to one another. This at first sight appears to be an unreasonable practice. But when one considers the great height to which the canes grow in good crops (some canes last year, when laid out, measured $26\frac{1}{2}$ feet in length over all), and the violent storms which usually occurs towards the ripening time, as well as the frequency with which the canes are attacked by numerous jackals and wild cats, it is difficult at present to suggest any certain improvement. Thashing can only be done with hard-rinded canes of a bunching habit.

The feeding of the cane and its general treatment have a great influence on the time required for ripening. It may be stated generally that, when starved, its growth is limited and ripening is hastened. The manurial plots on the Samalkota farm have been of a comparatively simple nature, being mainly devoted to the comparison of the effect of different

quantities of nitrogenous food in the form of oil-cakes. Analyses made at intervals for some months before harvesting have shown very conclusively the effect of such manures on the ripening of the canes in the heavy delta lands. In each and every case the rate of ripening was retarded in proportion to the excess of nitrogen in the manure. When a heavy dressing of oil-cake was supplied the crop was of great bulk, but the canes had not ripened after a full twelve months, whereas in the case of the application of ordinary "village manure," the canes ripened in 9 to 10 months. The application of manures must then be carefully considered, and nitrogenous manures in the form of oil-cake must not be given in too large quantities when it is desired to shorten the period of the cane's growth.

This latter fact brings us to the conclusion that it is generally useless to expect very large yields with a short period of cane growth, and that efforts at reducing the time in the ground are likely to be accompanied by a diminished yield. It may be stated as a general rule that, within certain limits, the longer the cane is in the ground the larger is the crop. It should be noted for instance that the enormous yields quoted from New South Wales are stated to be from canes 18 months old. In the same way some *Mojali* canes recently distributed from the Samalkota farm to a planter in Mysore were reported to produce $6\frac{3}{4}$ tons of jaggery to the acre at 18 months. This is the converse side of the problem. There are comparatively few places where the canes can be successfully grown for much more than a year, but it may be quite worth while to consider in special cases whether it will not be more economical to lengthen the period of growth instead of restricting it.

In conclusion, there is no doubt that certain canes require a longer period for their growth and maturity than others, although this subject is still rather obscure. The rate of ripening is obviously one of the first factors to be determined when introducing canes to fresh localities. There is great activity just now in bringing canes from the ends of the earth and trying them in various places suitable and the reverse. While some of these efforts will succeed, others will undoubtedly fail, and a record of these successes and failures will be of use in judging which canes are suited to which conditions. This opens a great field for observation which should not be left to the agricultural departments alone, but in which every cane grower should take part.

THE STUDY OF FERMENTATION AS APPLIED TO AGRICULTURE.

By C. BERGTHEIL.

Bacteriologist, Agricultural Research Institute, Pusa.

(PART II.)

IN a previous article (*Agricultural Journal of India*, page 68, Vol. 1), the study of fermentation was defined as the chemical changes which take place under the influence of living matter, and it was stated how essential this study has become to modern agricultural science, particularly in the endeavour to obtain a more intimate knowledge of the vital activities of plants. It is necessary to follow the matter a stage further than this, and to learn what is possible about the processes, which take place after the plant has ceased to grow and its substance is undergoing fermentative change. In the present article it is proposed to amplify this latter theme by considering a few special problems and to show how their study has led, or may lead, to practical results.

The term 'fermentation' naturally suggests to the lay mind something connected with spirits, and it was indeed in connection with operations involving the production of alcohol that the term was originally used. A consideration of the processes of spirit manufacture will serve to illustrate the type of problems which, though they have assumed an importance justifying a special technology of their own, are very closely allied to agriculture, since all the raw materials concerned are derived from the land.

Amongst all races and in every age we find a knowledge of some means for the production of alcoholic spirit, all fundamentally depending on the fermentation of sugar. A real understanding of the processes involved is, however, comparatively recent, and it is only by the aid of our modern conceptions of fermentation that the connection between agriculture and the manufacture of spirit has become clear. In many of the processes concerned, more especially those used in Western countries, we have to deal with

an enzyme action at the very beginning. Here the raw material is commonly some kind of grain, such as barley or rye, or some starchy tuber, such as the potato, all of which contain no sugar or only a very small quantity. The first operation necessary is the production of sugar from the starchy material. For this purpose, use is made of an enzyme action of a precisely similar kind to those mentioned in our previous article in discussing the germination of the seed ; in fact, the process employed is nothing else than the utilization of Nature's effort to promote the germination of the grain by supplying the embryonic plant with easily assimilable food. All starchy grains contain, and have the power of producing, a specific enzyme "diastase," whose special function is the conversion of the insoluble starch into a soluble sugar, and it is only necessary to put the grain under suitable conditions of moisture and temperature to promote the interaction of these substances and the resulting formation of sugar.

This is the preliminary operation of practically all processes of alcohol production from grain, and is exemplified by the so-called "malting" of barley preparatory to the preparation of beer or whisky. In this process the barley grains are placed under conditions favourable for germination and are allowed to grow until they have extended a shoot about half to three-quarters as long as the grain. By this time the maximum amount of diastase has been produced and the maximum amount of starch has been converted into sugar ; the process is, therefore, concluded by heating the germinated grain to stop its growth, for otherwise the sugar produced would be assimilated by the young plant and the maltster's object be frustrated. In the case of potato spirit, the operation is similar, except that here diastase has to be produced from grain as described above and introduced into the mass of potato starch as "malt," whilst, in the case of the Japanese "Moto," which is an alcoholic spirit made from rice, and of "saké" which is a beer prepared from the same material, we have a still more marked instance of the introduction of enzyme from an outside source, since reliance is placed entirely on diastase produced by a mould, with which the boiled rice is infected to bring about the necessary saccharification.

Modern study has taught us a great deal about the enzyme actions involved in these various processes. In the first place we have learnt that starch is the essential constituent of the many types of raw material from which alcohol is eventually derived and that, therefore, the production of a highly starchy grain (which, within limits, has also a correspondingly great diastase-secreting power) is the chief agricultural desideratum from the brewer's and distiller's points of view. This, of course, depends upon the plant selected for the purpose, on the soil in which it is grown and

its manurial treatment, so that pure agriculture is very closely concerned in the matter. Much has been learnt too of the effects produced by the other constituents of the materials used, by the bodies formed during the process and by the various conditions of environment (heat, moisture, acidity and the like), on the saccharifying processes. In every case the question must be considered from the point of view of enzyme action, and so much time and labour has been devoted to the study of this particular operation in the past that diastase is to-day by far the best known of all enzymes, and processes involving its use can be regulated with almost the exactitude of an ordinary chemical reaction.

It would be beyond the scope of the present article to go further into the detail of the preliminary operations involved in the manufacture of spirit. We have seen that the prime object of them all is the conversion of starch into sugar, and we will now consider the formation of alcohol from the sugar so obtained. Here we have to deal with a fermentation process which serves well to illustrate the view expressed in the previous article that the essential nature of all fermentations, whether produced by so-called 'organized' or 'unorganized' ferments, is probably the same, both being due to enzyme action. As is well known, alcohol is invariably produced industrially from saccharine liquids by the action of yeasts, lowly organisms closely allied to moulds, which possess the function of converting sugar into alcohol. In Western countries yeasts and their actions have been most carefully studied, and pure cultures of special yeasts, which have been found most suitable for the production of the particular type of fermentation desired, are deliberately introduced and their growth most carefully regulated and guarded; in other cases, such as those we are familiar with in India, wild yeasts are allowed to gain access from the air and grow in the liquid to be fermented, but under all circumstances a yeast or closely allied organism is necessary to the process. Until recently it was believed that this action of yeast in converting sugar into alcohol was due to some vital action of its protoplasm as distinct from a secretion of enzyme, and it was invariably cited as an instance in support of their views by those scientists who hold that there are some types of fermentation produced by micro-organisms which are independent of enzyme action and depend on some other type of metabolic operation of their cell-contents. The existence of an enzyme capable of converting sugar into alcohol in yeast cells was, however, conclusively proved in 1897 by Buchner, who succeeded in extracting it by submitting the cells to great pressure. In this way a clean liquid was obtained which, on being added to sugar solution, produced the evolution of carbonic acid gas characteristic of alcoholic

fermentation and the formation of alcohol in the liquid. The difficulty which had previously been found in extracting the enzyme was thus shown to have been due to the great tenacity with which it is held by the yeast cell-contents. It was found that a white solid could be precipitated from the liquid extracted from the cells, which was soluble in water and whose solution acted upon sugar exactly like the original extract; this solid represented the enzyme in a crude state and has been called "zymase" by its discoverer. So far this has had no pronounced influence on the industries concerned, it being still found more convenient to allow the yeast cell to elaborate the enzyme in the liquid to be fermented and produce the desired action, but the discovery is important from the theoretical point of view and suggestive of a line of investigation along which many other fermentative changes induced by organisms may be, and are being, studied with a prospect of obtaining a more intimate knowledge of their nature.

We have, however, occupied more space than the subject justifies by the consideration of alcoholic fermentation which, though it is connected very closely with agriculture, has been made the subject of so much special study that it has been well nigh removed from the sphere of the agriculturist. Problems with which he is more intimately concerned are those of the dairy.

Milk and cream are naturally ideal media for the development of organisms, so much so that a sample of cream ripe for butter-making has been found to contain as many as 1,500,000,000 bacteria per cubic centimetre, far more than those found in sewage or any other natural material which has been examined. It, therefore, becomes a matter of great industrial importance to preserve milk from harmful fermentations, particularly those occasioned by pathogenic organisms, and considerable attention has been devoted to this question in the past. The result has been the introduction of the system of "pasteurization," now so widely used in Europe and America, by which the milk is heated to a sufficiently high temperature to destroy most, if not all, pathogenic bacteria and a great many of those which occasion the rapid "souring" of milk not so heated, whilst avoiding the undesirable changes in flavour and chemical composition which would be produced by boiling.

In India where milk is a staple article of diet, where epidemic disease is rampant and the conditions of climate so suitable for the development of all bacterial growth, this question should demand special attention. The milkman of India is well aware of the desirability of boiling his milk in hot weather to prevent it "souring", but the importance of placing the milk in a clean vessel when boiled, and the dangers incurred if he does not do so, are by no means present to his mind. Much might perhaps be done by instruction and guidance in this direction.

In the manufacture of butter and cheese, a great many fermentation problems arise, which modern study has partly elucidated but many of which are still unsolved. In Denmark and America, where these subjects have been very thoroughly investigated, the bacteria which operate in the ripening processes of butter and cheese have been isolated and identified, and pure cultures of these organisms are used to promote these operations just as we have seen pure cultures of yeasts used in alcohol production, the result being a very much more economical method of working and products of very much finer and more easily regulated flavour than those previously obtained by leaving the fermentation processes to more or less chance organisms. Research has shown too that enzymes play a very important part in the dairy, since they are contained in normal milk as excreted and are responsible for a very large part of the changes which the milk undergoes in its subsequent conversion into butter and cheese. The preservation of butter also demands as close study as that of milk, and here again not only are bacterial problems involved but also a consideration of enzymes, which undoubtedly play a part in producing rancidity.

The bearing of these questions on Indian practice is at present unknown, but if dairying is ever to be an industry of any magnitude in India, and there seems no obvious reason why it should not, they will have to be reconsidered with regard to the special conditions holding in this country and the peculiar methods which native practice has evolved.

The question of the preservation of milk and butter products naturally leads to a consideration of that of other farm products. In almost every farming industry it is necessary to keep some kind of produce, particularly cattle food, after it is gathered until it is required for use, whilst it is absolutely essential to store some crops to render them suitable for food at all. In the methods used for this purpose we have to deal with several distinct types of fermentation. On the one hand we have to guard against the invasion of the stored material by harmful organisms as in the case of milk and butter, and on the other hand we have to encourage certain types of both bacterial and enzymic fermentations which lead to the production of a more stable or more palatable food. The preparation of ensilage is a good example of this. This process, by which green fodder may be preserved for long periods without loss of material and without ceasing to be good food, has been evolved as an outcome of the necessity for storing crops obtained during the summer months for winter feeding. The best method of attaining the desired end has been learnt by experience. It consists merely in placing the chopped

green food into large masonry towers from which all air can be excluded and packing it down very tightly. Only in recent years have the underlying principles been investigated and the procedure established on a rational basis, but we are probably still ignorant of many essential factors in the process. Originally the changes which take place in the material in the silos were attributed entirely to bacteria, it being supposed that aerobic bacteria operated in the first stages until all the air was exhausted from the tightly packed material, and that anaerobic organisms then concluded the process and were actually responsible for the changes produced. Modern investigation has, however, shown that this is not so and has made the probability strong that the preservation is due to some vital activity of the plant itself, which may or may not be exercised through the agency of enzymes. Certain it is that foreign bacteria must be excluded and the material so packed that they can gain no access. The chemical changes which take place in the material stored are profound and well merit further investigation, not only by reason of their theoretical interest but in order that their complete understanding may place us in a position to modify and adapt the method to conditions under which it has not yet been tried.

Probably similar courses of action take place during the storage of other food products. We know of many cases in which the crops as obtained from the land cannot be fed direct to stock without grave risk to health, whilst a few months' storage will render them excellent food. Mangel-wurzels afford a good example of this. The reason of the change has not yet been explained, though it is well known that the chemical composition is altered during the storage, and it is likely that it will be found due to fermentative action and subject perhaps to scientific control when understood.

Another branch of industry connected with agriculture in India, and one in which fermentation studies may lead to results of the greatest practical value, is the manufacture of textile fibres. India is remarkably rich in fibre-yielding plants and affords ideal climates for their cultivation, but hitherto difficulties in the way of preparing the fibres have stood in the way of the creation of really great industries. Jute is perhaps the solitary exception, and here we have a process of fibre extraction handed down from posterity and based, like so many other industrial processes, on little more than rule of thumb. Bacteriological study may throw some light on the question of jute retting and perhaps lead to the production of a fibre of higher value, but the principles evolved should be extended to other fibre plants, which promise to yield products of greater worth but which cannot be economically prepared by mechanical means.

In the previous article the fermentation of tobacco, tea and indigo were mentioned as types of those which must be studied. These are instances of true enzyme fermentations, though they were for many years considered dependent on bacterial action. It is not proposed to discuss them here. Sufficient has been said to show how wide and varied are the applications of fermentation studies to agriculture and the immediately kindred industries.

PLATE XVI.



NELLORE BULL.

A. J. I.

THE NELLORE BREED OF CATTLE.

BY MAJOR W. D. GUNN, M.R.C.V.S.,

Superintendent, Civil Veterinary Department, Madras.

THE Nellore breed of cattle has a wide reputation throughout India and even beyond its limits. Formerly the principal breeding localities were situated within the Northern Taluks of the Nellore District of the Madras Presidency, but recently these taluks have been included in the new District of Guntur, so the cattle should not rightly be given the name of Nellore, but rather that of Ongole, from which tract the best specimens of the breed are to be obtained.

It was formerly noticeable that cattle breeding received most attention in those parts of the country where circumstances of one kind or another were adverse to the extensive prosecution of agriculture. The cultivators were repeatedly deprived of the results of their labour, and were consequently considerably harassed : they, therefore, as a substitute devoted their time to raising large herds of cattle of a superior kind which were then much in demand, and which they saved from the grasp of the officials by moving them from place to place. Under more secure Government, these cattle breeders settled down, and being a fairly wealthy class, retained their pride in the fine cattle in their possession, with the result that many beautiful specimens may now be seen in this part of the country. The very best examples are to be found in the villages of Karumanchi, Nidamanur, Pondur, Jayavaram, Tungutur and Karavadi in the Ongole Taluk, and in Elapalacalan, Nennurpad and the hamlets along the banks of the Musi in the Kandakur Taluk. Fine cattle of this breed may also be found in the Taluks of Vinukonda and Narsaraopet in the Kistna District. In the southern part of the Nellore District where wet crops are grown, the cattle are much inferior, not being so well cared for or fed as in the places above named.

The system of feeding observed by the ryots of the different parts of this country naturally depends upon the extent of the pasturage. In the low-lying parts where paddy is principally grown, a certain portion of dry

land is often kept as a pasturage for cattle. Most of the cattle, however, leave the villages during September and October—the southern rainy season—and are sent to the Western Taluks where there are extensive waste and jungle tracts. Part of the working cattle will occasionally follow the other cattle during November and December, should the pasture land of the village not be sufficient. The ryots often club together and send their cattle away in large herds. For this purpose, prior to the departure of the cattle from the village, arrangements are made for renting pasture blocks at a fixed sum for the season (October to February), or engagements are entered into with the holders of the pasture farms for the pasturing of the whole herd for the season at a small fee per head for each full-grown animal. Should the North-East monsoon be favourable and extend till late in the season, the cattle are only pastured until January when the paddy is harvested, after which there is very fair grazing. The whole of the jungle grazing is not open to the cattle at all times, for after a heavy burst of rain, invariably experienced about October, the best portion of the pasturage is preserved and kept clear of cattle for one or two months until the grass has grown up well, when the working cattle alone are turned in and kept thereon so long as the pasturage suffices, another portion being similarly kept for the other cattle. Towards the end of January, when the sorghum crop on the higher land has come into ear, the young shoots termed *Zadu*, which are not likely to mature, are removed and given to the bullocks, which are often picketed close to the fields. Occasionally fields in the midst of cultivation are set apart for pasture and are planted with the black and white varieties of *Acacia*. After being under grass for ten or twelve years, the ground is cleared of trees and broken up for cultivation. The trees shade the ground and favour the growth of grass, whilst the pods form good fodder. The pasture land held in this way is invariably distinct for each ryot and is generally kept exclusively for working cattle, young stock and milch cows.

The country where the best cattle are raised is undulating highland interspersed with small hills, and is mostly composed of light red or dark alluvial soil, where good sorghum, other millets and legumes are raised. The well-to-do ryots in these parts find their pleasure and pride in raising fine cattle.

There is no greater truism than that which refers to the necessity of feeding young stock, and the very great care which the best breeders bestow on their young animals, both male and female, most certainly accounts for the well-deserved reputation of the Ongole cattle. The young calves are allowed to suckle the whole of the cows' milk, and when they are three months old are given grass and a small ration of mixed grains. In every

PLATE XVII.



SHORTHORN BULL.

J. J. J.

way they are treated and tended as the family pets, and it is only by going into the houses of the villages that the best calves can be seen.

That there is considerable profit in the undertaking is evidenced by the high prices which the animals realize. Young bulls sell from Rs. 80 to Rs. 250. Several fine animals have been exported to South America. A good Nellore cow is worth from Rs. 80 to Rs. 150 according to the amount of milk she yields.

Ghi (clarified butter) is made in fairly large quantities and sold to merchants for export, being seldom used by the ryots, who prefer gingelly oil for cooking, and reserve the ghi for sale. A good Nellore cow gives from 11 to 14 lbs. of milk daily.

The breed is probably not so hardy as the *Mysore* or *Alumbadi*, but for slow heavy work they are unsurpassable, and they are universally employed for drawing very heavy loads in the city of Madras, frequently amounting to five tons.



The characteristics of the breed are :—

Head.—Face moderately long ; muzzle fine ; forehead broad ; eyes elliptical in shape, large and mild ; skin round the eyes is black for about half an inch ; ears long and drooping ; horns short and inclined to be stumpy ;

in cows the horns are longer than in bulls ; they are directed outwards and slightly backwards.

Neck.—Short and thick.

Hump.—Well developed.

Body.—Massive, long and deep, but some are inclined to be flat-sided. In fine specimens, the girth behind the hump is about 84 inches, height behind the hump 63 inches.

Back.—Of moderate length and invariably higher at the croup.

Quarters.—Strong with a considerable droop.

Sheath.—Pendulous ; cows have also a fold of skin in the position of the sheath.

Tail.—Long, fine and tapering.

Legs.—Strong and somewhat coarse.

Feet.—Large and somewhat soft looking.

Colour.—Black and white, and pure white ; the latter is now most esteemed, but formerly black and white was the predominating colour.

Temper.—Very docile.

The extensive pasturage obtainable in this part of the country is no doubt responsible in a great measure for the large cattle-breeding industry, which Government has always been careful to foster. Previous to 1867 a poll tax used to be levied, but in that year this was abolished in Nellore, and a principle was laid down for the future that, out of the waste of each village, an area equal to 30 per cent of the area occupied by cultivation should in future be reserved for common grazing, to be equally enjoyed by all villagers free of charge ; the surplus waste, if sufficient in extent to make it worth while to adopt the system, may be leased out for one or two years at a time to the highest bidder.

In order further to develop and encourage the breeding of good stock, an annual cattle show was established so far back as 1858, and continued uninterruptedly until 1871. During these twelve years a total of over Rs. 18,000 was distributed in prizes. The cattle show was resuscitated last year with most successful results, and it is doubtful whether such a large collection of bulls and cows of one breed have been brought together before in India. There were exhibited :—

Brahmini bulls	...	...	...	..	...	45
Bulls	...	...	...	...	..	120
Bull calves	...	...	...	...	..	83
Bullocks, single	...	...	...	...	...	22
Bullocks, pairs	...	...	...	...	...	31
Cows	...	...	...	...	...	166
Carried over						467

PLATE XVIII.



NETTIE COW AND CALF.

A. J. L.

			Brought forward	...	467
Heifers ...	...	...	...	...	132
Buffaloes, bulls ...	...	...	...	...	1
" bullocks ..	...	...	...	...	2
" cows ..	...	...	...	...	6
Rams ...	...	...	...	...	38
Ewes ...	...	...	...	...	3
Goats, he ...	...	...	...	...	11
" she ...	...	...	...	...	3
					670

The heifers and young bulls were an exceedingly good lot, and it is most sincerely to be hoped that, with the encouragement held out by the Madras Government, the show will be held annually and equally well represented.

Great care is taken in the selection of the village bull, and the collection of *Brahmini* bulls brought into the show at Ongole consisted of forty-five handsome upstanding animals in splendid condition. Almost every village has one or two so-called Brahmini bulls, which are common property, having been presented by the relations of a deceased villager as a memorial, or by some wealthy ryot, or having been purchased by public subscription. Such animals are always branded with a sacred mark.

Like all agricultural classes the ryots of the East Coast are very superstitious. They are usually very unwilling to exhibit a favourite cow owing to the influence of the Evil Eye (*Drishti*). A bullock whose tail has the root of the tuft of the hair situated above the hock is said to have *Eru-val* and to bring ill luck. This is not objectionable in the cow. A bullock having white hair, skin, horn and hoofs is considered of weak constitution and not to be purchased. A black bullock is generally considered a rogue; if not a rogue, he is considered of great value. The saying is:—"A black bullock is but the fourth of a bull, but if he is guileless he is a bullock and a quarter." A bullock with numerous small spots over the body "like a deer" is considered very lucky.

The form of the horns is supposed to indicate many things and receives as many names. For instance, *Madakkambu* means horns bent backwards, and is considered an excellent sign in a cow. There is an old saying:—"Let any man, who does not know how to select a cow, purchase one with horns bent backwards." Straight horns are liked. Horns pointed forwards—*Kopadi*—indicate spirit. Irregular, twisted horns—*Churuttai*—are not objected to. Those which appear hollow and have light coloured patches—*Kalkumbu*—are considered very disastrous. Horns with white tops—*Punkumbu*—are

also bad. If a cow at the time of purchase voids urine, it is considered a very good omen, but if she passes dung it is a bad sign. The reverse is the case with the bullock.

A bullock, which fails to cut the fourth pair or corner incisors, is called *Arukatti-Madu* and is considered lucky. The saying is:—"He who purchases a bullock with only six permanent teeth (incisors) will become rich enough to purchase an elephant." A bullock which cuts only seven permanent front teeth is unlucky to its owner, and is responsible for the saying that "He who purchases such a bullock should have the preparations for his funeral made ready."

Certain observances are most scrupulously carried out by both purchaser and seller at cattle sales and, in fact, have become unwritten law resting for authority on long consent. Disregard of these details in the procedure is seriously believed to imperil the prosperity of the owner, the seller and the innocent animal. The following are the principal ones:—

(1) After the price has been fixed, the buyer hands the seller a silver coin, either a two-anna bit or a rupee as earnest-money.

(2) The balance of the money may be paid at once or at any stated time afterwards.

(3) The seller has to pay the purchaser a four-anna or eight-anna bit for what is called *Maralu labham* or *Pathi Vithamalu* (cotton seed). It is intended that this money should be used by the buyer for fodder for the animal for that day. The purchaser is always careful to go with four-anna pieces in the event of the seller not having change for a rupee.

(4) The buyer must never tie up the animal with his own rope and, therefore, a purchaser never carries one.

(5) The seller must always supply the purchaser with a new rope, and if it is not available, he gives the purchaser raw material which must be braided or twisted into a rope. The seller must never give the rope already used by the animal.

(6) The seller in company with the purchasers should for a short distance lead the animal himself with the fresh rope and then transfer the rope to the hands of the purchaser who then takes the animal home. This settles the sale contract and is never disputed. The conditions of sale are never reduced to writing.

MINERAL FERTILIZERS IN INDIA.

By F. G. SLY, F.C.S.,

Offg. Inspector-General of Agriculture.

IN connection with the possible introduction of a sulphuric acid industry into India, it is interesting to consider the scope for the use of mineral fertilizers in Indian agriculture. The information available upon this subject is summarized in the following note.

Phosphatic manures, mostly in the form of crushed bones and superphosphates, have been under trial for several years at some Government Experiment Stations. The results of sixteen years' trials at Cawnpore give the following average yields in lbs. per acre :—

	Maize,	Wheat
	lbs.	lbs.
Unmanured	760	1,193
Saltpetre and bone-dust	1,280	1,697
Saltpetre and superphosphate	1,194	1,718

The results are discussed in detail in *North-West Provinces' Bulletin* No. 9 of 1900.

At the Nagpur Farm the average results have been as follows :—

	(irrigated wheat) (11 years),	(unirrigated wheat) (17 years),
	lbs.	lbs.
Unmanured	413	470
Bone-dust	572	590
Saltpetre and bone-dust	872	791

Crushed bones have thus produced only a small increase of yield. At the Dumraon Farm, the use of bone-meal has increased the yield of wheat from lbs. 423 to 720 (average of seven years) and of paddy from lbs. 946 to 1,412 (average of four years).

The best results have been obtained at the Burdwan Farm, where the average of 14 years' experiments on paddy is as follows :—

					lbs.
No manure	(14 years)	...	...	...	1,549
Bone-meal,	3 maunds (ten years)	...	...	...	3,663
Do.	6 maunds do.	...	...	...	3,962
Do.	9 maunds (four years)	...	...	...	3,033
Bone-meal,	3 maunds and saltpetre 30 seers (10 years)	...	...	...	4,393
Do.,	4½ maunds and saltpetre 1½ maund (four years)	...	...	...	2,860

The results obtained on the farm have thus been exceptionally good. The use of bone-meal (3 maunds) and saltpetre (30 seers) has given an annual profit of Rs. 86 an acre in excess of an unmanured plot. This result is corroborated by other experiments, which show that the alluvial soil of the lower Ganges valley responds readily to phosphatic manures, particularly if applied in conjunction with organic manures. This manure can, therefore, be strongly recommended to the rice cultivators of Bengal, who should also practise green-soiling in order to get its full results. The bone-meal should be spread evenly over the field and thoroughly worked into the soil at the first and second ploughings. The saltpetre should be given as a top-dressing, when the seedlings are thoroughly established after transplantation ; in order to secure an even distribution, the saltpetre should be mixed with four times the quantity of powdered earth, and applied in two dressings with an interval of about a fortnight between each.

At the Manjri (Poona) Farm, bone-meal and superphosphate were employed in a series of manurial experiments on sugarcane, but they proved distinctly less useful than the organic manures employed (see Agricultural Ledger No. 8 of 1898).

The general result of these experiments has then been that bone phosphate has not given any large increased yields of cereals except in the Ganges alluvium of Lower Bengal. This corroborates to some extent the results of soil analyses, which show that the available phosphoric acid is not generally deficient in Indian soils except in Behar and Assam. And in this connection it may be added that superphosphate is largely used for root crops in England, which are not generally grown in India. It seems improbable that there is any immediate prospect that superphosphate at its present price will come into general use as a manure under existing agricultural conditions. In most parts of India the soil responds more readily to nitrogenous manures. The enormous export of bones (nearly 100,000 tons a year) means, however, a very large drain on the soil, which must in time require replacement, as it is not at present counterbalanced by the use of phosphatic deposits or by imports. It would, therefore, seem that in time the nitrogenous manures will

require to be supplemented by phosphates. The establishment of a sulphuric acid industry would alter existing conditions in favour of the use of phosphatic manures by the decrease in price that would result. Phosphates occur in the form of apatite as a by-product of the mica mines of Chota Nagpur, but the output is too small to be of any importance. This phosphate has been tried on a small scale with poor results. Phosphatic nodules occur in large quantities at or near the surface in the Trichinopoly district of Madras. These deposits were investigated by Dr. Warth in 1892, and an analysis by Dr. Voelcker shows that the amount of phosphate of lime is fairly high, comparing favourably with Carolina and English Coprolites, but that it is not well suited for the manufacture of superphosphate, as the quantities of carbonate of lime, iron and alumina are high, involving waste of sulphuric acid. It would thus probably pay neither to export nor to manufacture. It might be used as a slow acting fertilizer in a crushed state, but the freight charges by road are very heavy. It is already worked on a small scale to provide manure for coffee estates. The phosphate of lime found in the Christmas Islands, which is shipped largely to Japan, Australia and Europe for use by artificial fertilizer manufacturers, can be landed in bulk at Calcutta at about £2-10-0 per ton, but in its raw state it could hardly compete with bones at their present prices, making allowance for the nitrogen in the bones. Christmas Island phosphate might, however, be less costly than any indigenous material if a sulphuric acid industry could be established. The analysis of these materials is compared in the following table :—

				Apatite (Hawthorn) from mines (a).	Trichinopoly phosphate (a).	Christmas Island phosphate (b).
Moisture	...	...	...	0.37	1.62	0.71
Organic matter	...	...	...		2.71	2.80
Lime	...	...	...	36.42	37.22	
Iron and alumina	...	...	...	1.89	11.90	2.01
Alkalis, etc.	...	...	...	3.60	7.76	
Phosphoric acid	...	...	...	28.50	22.83	38.89
Carbonic acid	...	...	...	0.00	3.74	1.90
Silica	...	...	...	20.90	10.40	0.10
Calcium phosphate	...	...	...	61.98	19.84	84.90
Carbonate	...	...	...	...	12.62	4.43

(a) Analysis made by Dr. Leather, Imperial Agricultural Chemist.

(b) Analysis supplied by the Director, Geological Survey of India.

I may mention some other mineral fertilizers. Gypsum is found in large quantities in the salt range of Northern India and is locally obtainable in smaller quantity at several places. It deserves special notice because it is an antidote to certain classes of saline soils (*usar* or *reh*), but the cost of

reclamation with gypsum is more than the value of the land owing to the heavy freight charges by road and rail. Nitrate of soda has lately been tried at several experiment stations, but the results are not definite.

I have omitted to notice sulphate of ammonia because the trials of this chemical have been very few. Experiments upon tea with this manure were made by Dr. Mann, but did not give successful results. It is also improbable, owing to its chemical action, that it would suit the ferruginous soils of the Mysore plateau. It is, however, used in enormous quantities for sugarcane cultivation in Java and Mauritius, both of which countries are importing into India an increasing amount of sugar, and it deserves a careful trial by sugarcane growers in India. A plant for the manufacture of ammonium sulphate has been introduced by Messrs. Waldie & Co., Calcutta. Arrangements are also already well advanced for the erection of by-product recovery ovens in coke-making, whilst with the establishment of the Tata iron and steel manufacturing concern, the output of ammonium sulphate will be large. Arrangements are also being made for prospecting the copper sulphide deposits of Chota Nagpur, and if they prove as valuable as is asserted by some authorities, it is probable that a large chemical and metallurgical industry may be started, the by-products of which will include sulphuric acid and ammonium sulphate. It is naturally to the interests of India that these should be utilized as far as possible in the country rather than exported, and the agricultural departments should make experiments to test their utility in cultivation, particularly that of sugarcane.

The use of artificial fertilizers seems to be coming nearer within the scope of Indian Agriculture, and the establishment of a sulphuric acid industry might have important results. It is the duty of the Department of Agriculture to anticipate such a movement by a careful trial of fertilizers at Government Experiment Stations. A series of experiments upon cotton with various manures, including superphosphate and sulphate of ammonia, have been started at several Government Farms, and in time these trials should be extended, more particularly to sugarcane and other valuable irrigated crops. If such fertilizers ever come into general use, the question of guarantee of quality will become of importance.

NOTES.

AGAVE FIBRE IN ASSAM.—As many inquiries are received about the prospects of sisal and other agave fibres in India, it may be of interest to record the impressions derived from a visit to the plantation of the Dauracherra Fibre Company, Sylhet, Assam. The best account of the prospects of establishing an agave fibre industry in Assam is given in Mann and Hunter's book "Sisal-Hemp Culture in the Indian Tea Districts" (Thacker, Spink & Co.), but this note may supplement the information therein given by some facts derived from later practical experience.

The Dauracherra concern is the largest fibre company in Assam, about 1,000 acres having been planted out with agaves. There are other plantations in Assam, the total area under agaves being about 3,500 to 4,000 acres. At Dauracherra, most of the land is devoted to *sisal*. There is also some Mauritius hemp (*Fourcroya gigantea*) which grows equally well but is not so popular, because there is no suitable machine for its treatment on a large commercial scale. The machine at work at the factory is the Torruella, which has given complete satisfaction in the treatment of sisal, but the strain is too great for the weaker fibre of Mauritius hemp. All other varieties of agave have been discarded after trial as being in no respect equal to sisal. It is estimated that one Torruella machine (price £600) will treat the produce of 600 to 800 acres of sisal. Some portions of the plantation are now commencing to come into full yield, and it is stated that the outturn may be placed at half a ton of dry fibre per acre at a low estimate. The green leaves yield about 4 per cent of dry fibre, of which three parts are good straight fibre equal to sisal from other parts of the world, whilst one part is made up of short uneven fibre ("tow") fetching about one-third of the price of the former.

Dauracherra is situated in the valley of the Surma river, some 60 feet above sea-level with an average rainfall of about 80 inches. The climate is fairly equable with no intense cold or heat, whilst showers are received off and on almost every month. For instance in the so-called dry season, rain

usually falls about Christmas, and there are generally good showers from March onwards until the regular monsoon. The country is thus exceptionally favoured for the continuous growth of vegetation, so that the sisal has no prolonged period of rest.

The growth of the plants was certainly good and fairly even. It is planted out on the tops and sides of a succession of small hills (called *teelas*), but although the country is thus considerably broken up, the soil seems a fairly good loam even on the slopes and tops of these hills. The soil is thus nothing like as poor as the bare laterite plains of the Deccan. It is virgin land, which was under a dense growth of mixed forest before it was reclaimed. The plants are generally more advanced in the richer soil of the intervening valleys, but the greatest care is required to keep these thoroughly drained. Any water-logging is fatal to sisal. The percentage of fibre is somewhat smaller in the larger plants in the valleys, but this may be compensated for by the quicker growth. Clay soils are unsuitable, an open loam being the best. Shade is bad for the plants, resulting in long thin leaves, which do not give such good fibre.

The plantations have as a rule a good even stand of plants, without the inequality which is so marked a feature of the Hindupur Fibre Station of the Madras Department of Agriculture. This evenness of stand is, perhaps, largely due to the considerable care exercised in setting out the plantation. The young plants should be at least one foot high, and even larger if possible. All weakly plants are discarded. Suckers are preferred to plants raised from bulbils in the nursery. Pits are dug about 1 foot deep and $1\frac{1}{2}$ foot square. In the earlier years the plants were set out too far apart; the most economical distance is now said to be 9 feet by $4\frac{1}{2}$ feet by $4\frac{1}{2}$ feet, *i.e.*, two rows $4\frac{1}{2}$ feet apart with $4\frac{1}{2}$ feet between plants in the row, and then a space of 9 feet for convenience in harvesting the leaves. Mann and Hunter's book gives perhaps a somewhat exaggerated idea of the amount of cultivation. The land is not hoed nor weeded in the ordinary sense of these terms, not even close round the plants, but the whole area is kept clear of rank tall grass and scrub by cutting it down as often as is necessary.

Crickets do a certain amount of damage by cutting off clean the hearts of young growing plants; no effectual remedy has yet been discovered. There are also two or three fungus diseases which attack the leaves, but these have not as yet done very much real harm. It is not believed that any of them will become a serious pest. An account of these fungus diseases is given in a subsequent note at page 261 of this Journal.

There is no definite information as to the age at which sisal will flower under plantation treatment. Some untreated plants have poled at ages varying

from 8 to 12 years, but it is believed that the life will be longer of plants, the mature leaves of which are regularly cut. The plantations yield about two heavy or three light cuttings a year, the latter being of course a preferable method of harvesting where labour is cheap. The waste vegetable matter from the factory is not at present utilized.

Although most of the plantations are as yet too young to yield definite results, the Company seems quite satisfied with its prospects. Whether equally promising preliminary prospects could be secured in other parts of India with less favourable conditions of soil, climate and rainfall, is a matter of more doubt.—(F.G.S.)

CO-OPERATIVE EXPERIMENTS.—In Bulletin No. 3, Vol. VI, of the West Indies Department of Agriculture, an interesting account is given of a set of manurial experiments on cotton made by planters on their own estates, under the guidance of the Department of Agriculture. The value of such co-operative experiments should be very real in India, provided that too much is not attempted at once and that the issues under consideration are limited. In this case the crop experimented on was cotton, and a list of thirty-eight plots was drawn up. These were 1-40 acre in size, and were divided by rows of pigeon peas (arhar or tuer, *Cajanus indicus*), the whole series taking up about one and-a-half acre in all. Twelve estates succeeded in carrying their experiments to a successful conclusion, and the results are published in detail, with additional figures giving the average yield of all the stations in pounds per plot and per acre, and the excess or otherwise per acre, due to the application of manures.

The subject of co-operative experiments is no new one. As far back as 1886, the Bath and West of England Society instituted organized co-operative manurial experiments of this kind. It is to be noted that the object of these experiments was not so much the discovery of any new manurial principles, but the demonstration and confirmation of lessons already deduced from observations made at such stations as Rothamsted and Woburn. It seems likely that there are few other methods so efficacious in educating the farmer or planter to use his own judgment in the application of manures, and in stimulating him to carry out simple manurial tests on his own land for his own benefit. The general results obtained from such co-operative schemes will clearly indicate the general nature of the manure suitable for any crop, whether nitrogenous, phosphatic, potassic or combined, while a careful study of the variations obtained at different stations, especially if these stations are on estates with which he is familiar, cannot fail to inculcate the importance of varying the manure to suit the land or the system of cropping employed.

This last factor is one of real importance, and in drawing any results from figures obtained in an experiment, the previous crop and its treatment should always be borne in mind.

Another point to which attention should be paid is the duplication of plots. It would no doubt be perfectly easy for many landowners to choose a site for experiments which they knew from past experience to be uniform, and from which results perfectly satisfactory to themselves could be drawn, but from a scientific point of view, the results are much more convincing and carry more weight with people who have had no opportunity of seeing the experiment, if some or all of the plots are checked by this method.

With regard to size, the plots should not be smaller than 1-20 of an acre, and might with advantage be larger. Care should be taken to keep the plots quite separate, and in the case of a crop like sugarcane it might be well to manure say twelve rows, but to cut and weigh only ten, disregarding the outside rows as being influenced by neighbouring plots. The manures chosen should be such that one or more definite issues are raised which may be answered directly by the results obtained. Thus the relative value of nitrate of soda and sulphate of ammonia for a certain crop could easily be decided by laying out a four-plot test as follows :—

No manure.	Complete manure, containing sulphate of ammonia.	No manure.	Complete manure, containing nitrate of soda.
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and a definite answer to this enquiry would be obtained. The quantity of a given manure which it is profitable to apply might be discovered by manuring a large plot with the other constituents of a complete manure, and then dividing it into strips on which the quantity of the manure under consideration might be varied.

We recognize that in many cases Indian conditions are not favourable to tests of this character : the small size of holdings and the character of the cultivators in some cases prevent the adoption of such a system ; but where conditions are favourable, provincial departments should be able to draw up simple schemes of manurial tests on selected crops, which should furnish valuable results under a system of careful supervision by the agricultural staff.—(R. C. W.)

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JUTE EXPERIMENT.—The Bengal Department of Agriculture has issued a leaflet giving the results of the jute experiments conducted last year at the Burdwan Government Farm. These include trials with different manures, cutting the crop at different stages of growth, testing numerous varieties,

spacing the plants at varying intervals, sowing broadcast or in drills, and sowing seed obtained from an ordinary crop and that obtained from a crop grown much more thinly for seed purposes only. The experiments have only been in progress for a couple of years, so that reliable results cannot yet be expected; but so far as they have gone, they mostly confirm the practices ordinarily followed by jute cultivators. A mature crop gave a larger outturn of fibre than a crop cut at an earlier stage, but the quality of the fibre is not given. Cowdung gave better results than all the other manures, which included ester-cake, bone meal and saltpetre. This confirms the general conclusion obtained from experiments with other crops that the Ganges alluvial soil is deficient in organic matter. We should like to see a plot added in order to test the effect of the application of phosphates in combination with organic matter, which has been very successful with other crops. Sowing in lines four inches apart, gave better results than sowing at wider distances and than broadcasting. The testing of varieties has not yet given definite results.—(F. G. S.).

EXTENSION OF JUTE CULTIVATION.—The first experimental trials of jute in the Godavari delta of Madras and in the Central Provinces have not been successful. In both cases, the failure seems to be mainly due to the same cause—the waterlogging of the plots in the early stages of growth. The young jute plants were damaged by the plots being kept under water. Whilst jute will tolerate prolonged flooding in the later stages of growth, it is very sensitive to an excess of water in its young stages even in Bengal. This error will be avoided in the present year's trials. Trials on a commercial scale will also be made by a Madras firm at Rajahmundry in the Godavari district. The Eastern Bengal and Assam Department of Agriculture have, further, arranged a scheme for the extension of jute cultivation to the upper districts of Assam. Mr. Finlow, B.Sc., Jute Specialist, has completed a tour in the Bombay and Madras Presidencies and the Central Provinces, in order to investigate the possibilities of the extension of jute cultivation in those parts. His report, which will shortly be published, should give much valuable information about this important subject. There is little doubt that the present demand for jute is in excess of the supply, and several countries are now endeavouring to introduce the crop, notably Java and West Africa. The Inspector-General of Agriculture has recently supplied 5,000 lbs. of seed to the Colonial Office for trial in West Africa. If India is to retain her monopoly of the world's supply of jute, it seems clear that there must be a considerable extension of cultivation.—(F. G. S.)

SELECTION AND DISINFECTION OF SUGARCANE CUTTINGS.—Some useful instructions are given in Bulletin No. 1 of the Hawaiian Sugar Planters' Experiment Station regarding the selection and treatment of sugarcane sets used for planting. There is probably no part in the whole operation of the cultivation of sugarcane, where a little time can be so profitably spent as in the inspection and disinfection of the cuttings to be employed for seed. The maxim, "the best is none too good for seed" is a true one, and though on many estates the loss from disease may be small, and the extra expense of careful supervision not fully justified, yet our knowledge of many of the diseases of cane is so slight, and their attacks are often so insidious, that the omission of such precautions is always a risky proceeding.

Firstly, then, every cane planter should become thoroughly familiar with the appearance of healthy specimens of the variety to be planted; every cane that shows any departure from this should be unhesitatingly condemned. There is no doubt that this rule will in many cases act so as to exclude the greater number of the cuttings; but even if this is the case, the inclusion of any such canes in the seed is fraught with the danger of propagating the disease. Special attention should also be paid to the area from which the seed canes are cut; this should be from the healthiest field on the estate and should be carefully inspected previous to harvesting, care being taken to remove all patches which are stunted or poorer in any way than the surrounding crop.

There is the greatest need for the exercise of care in this respect in Behar, since it has been established that one of the chief modes of propagation of the disease known as red rot or red smut (the so-called "rind disease" of the West Indies) is by the planting of sets already containing the fungus. When the parasite is present in the sets, its existence is generally betrayed by a reddening of the tissues which can easily be seen at the cut ends. Every set showing such reddening should be discarded. Some twenty-five cane varieties from all parts of India have been grown at Pusa for the last two years and treated in this manner, with the result that red rot has practically disappeared from all but two. It is not suggested that this is the only method of propagating the disease, but in Behar it is by far the most important, and selection of cuttings should become established as a routine practice in sugar planting.

Having thus taken all precautions to obtain healthy cuttings attention must be given to the methods available to prevent their infection while in the ground. The cane is provided with a hard cuticle which is an effectual barrier against the entrance of fungus, but the cut ends expose it to a risk of infection. To minimise this, the cut ends should be as clean as possible:

the knife used should be sharp, and the cut should be given with a slicing motion as thereby the shattering of the cut ends is avoided. Care should be taken to give each eye as much cane as possible upon which to draw for its nourishment in its early growth.

The canes may now be disinfected with various mixtures of copper, such as Bordeaux Mixture or pure copper sulphate solution; this will effectually prevent the growth of any fungus spore which may come in contact with the cut end. Here again we see the importance of having a clean-cut end; for if a shattered end is dipped in the liquid, air bubbles are enclosed in the fractures, and portions of the surface are left untreated and thus offer an open door to the attacks of fungus.

It will thus be seen that the production of good seed is the result of the observance of a number of details each in themselves insignificant. The net result, however, may often prove to be the difference in value between a healthy and a diseased crop of cane.—(R. C. W.)

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COTTON CULTIVATION IN BURMA.—A report on cotton cultivation in Burma, recently published by the Department of Agriculture, discusses in considerable detail the possibilities of the extension and improvement of cotton in that country. It has been urged by some authorities in England that Upper Burma is a most promising country for the growth of long staple cotton, but this report does not hold out much prospects of success. Cotton is already a well-known crop in the dry zone of Upper Burma, but the area averages only some 150,000 acres and shows no tendency to increase. The principal variety is similar to that grown in Bengal, from which country it is believed to originate, and produces only coarse lint about equal to "Fine Bengals." The best of the crop is carried by road across the Chinese border, but the bulk of the exports go by sea to Japan, China and India. As a rule, it is only the poor land that is put down to cotton, for it is not such a paying crop as many others. The rainfall is notoriously precarious; in some years the cotton is damaged by heavy falls, whilst in others it suffers from drought. In the principal cotton-growing tract around Myingyan, late rains often spoil the crop just before it is ready for picking, whilst in Prome cold cloudy weather about Christmas time injures the flowers. The crop receives little attention, the methods of cultivation being very primitive; the seed is scattered broadcast, thinning and weeding are done very sparingly, so that good yields can hardly be expected. The short supply of labour and the consequent high wages are a great handicap against cotton, which requires a good deal of cheap labour. The want of good communications also prevents any considerable cultivation of such a bulky

crop, which demands cheap means of transport. For these reasons, the Burma Department of Agriculture rightly concludes that under existing conditions there is little prospect of the extension of cotton cultivation in Burma.

The Government of India consider, however, that the conditions would be considerably altered if the quality of the lint could be largely improved and the yield increased. With larger profits from cotton cultivation, many of the difficulties now experienced would disappear. So far as climatic conditions are concerned, there seems *primâ facie* nothing to prevent the growth of finer varieties. The possibilities of growing Egyptian and other long-staple cottons under irrigation should not be neglected, for such a crop, if successful, should be able to compete with rice. There are thus many matters which require to be settled by experimental work by the Department of Agriculture, before it can be definitely stated that fine staple cotton cannot be profitably grown in Upper Burma.

The report contains some information concerning the so-called "Pernambuco" variety of cotton, which is a perennial tree-cotton with kidney seed, producing fine silky lint of good quality. Owing to some high valuations of this cotton, it has attracted more public notice than it seems to deserve. It is not at present grown as a field crop, a few scattered plants being found in some house-gardens of villages. There seems to be nothing to distinguish this variety from the similar plants found under the same conditions in many parts of India, the superiority of the lint being probably due to the favourable climatic conditions along the sea-coast in Tenasserim. Experiment has yet to show whether it can be successfully grown as a field crop.—(F. G. S.)

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THE EFFECT OF AMMONIA SALTS IN CERTAIN EXPERIMENTS IN ENGLAND.—One of the most famous agricultural experiment stations is that situated on the Duke of Bedford's Estate at Woburn in England, which is controlled by the Royal Agricultural Society of England. Among the numerous experiments conducted there, is one in which wheat on one set of plots, and barley on another, are cultivated every year. For each crop there are eleven principal plots (some of which are subdivided), and each of these plots is treated and manured in one or other special manner every year. In the present instance we are concerned with those plots only on which ammonia salts have been applied. The experiment has been in progress for thirty years, and until upwards of twenty years had elapsed, nothing unusual was noticeable in regard to either of the crops. About this period, however, the barley commenced to fail on the plots manured with ammonia salts, and the decline

during the succeeding years was very rapid, culminating in absolute failure. The wheat has been affected in a less degree. Obviously in such a case, the question arises whether this result is attributable to the fertilizer or to some special feature of the soil or to both combined. The ammonia salts employed have consisted of equal parts of the chloride and sulphate, containing 50 lbs. or 100 lbs. of ammonia per acre per annum on different plots. It may be stated at once that, although the chloride (muriate) is not commonly used for this purpose, the sulphate finds a very wide and indeed general application in Europe and America, and this fact alone must negative any suggestion that sulphate of ammonia is of doubtful utility. Another useful piece of evidence in this connection is the fact that these two salts have been employed in a precisely similar manner for wheat and barley at the Rothamsted Experiment Station for over sixty years: they have been added to the same plots of land year after year over this long period, and here both the wheat and barley continue to grow in a normal manner. The evidence, therefore, goes to show that the effects which have been experienced at Woburn must not be attributed simply to an evil effect of the ammonia salts.

As a matter of fact one suggestion occurs almost immediately to those who study the chemistry of soils and manures. It is well known that the ammonia of these salts is changed in the soil through bacterial agency into an altogether different substance, namely, nitric acid. Such a substance, however, will not remain a free acid if it is in contact with any of the opposite class of substances, namely bases, so that if the latter are present in the soil in sufficient amount, the nitric acid enters into a state of combination with one or other of these bases and forms a salt, one or other of the nitrates in fact.

A second point to notice is the fact that so soon as the ammonia suffers the change described, the acid—sulphuric acid and hydrochloric acid in the salts used at Woburn and Rothamsted—with which it was combined, is also set free, and, like the nitric acid, will combine with bases which may be present to form new salts. Thus there is on both hands a requirement of base year by year. The base usually most readily at hand in the soil, and indeed the one most desirable, from the agricultural point of view, is lime. The quantity involved in any one year is quite nominal. The ammonia salts employed at Woburn would occasion the neutralization of only some two or three hundred pounds of slaked lime per acre. On the other hand, soils contain generally 50 or 100 or more times this quantity. But if these salts are applied to land year by year, and if at the same time the whole quantity of lime present in the soil is only small, then the ultimate effect

will be a serious reduction of the free lime present, followed also by the natural consequence that the crops will suffer. Unlike the Rothamsted soil which contains a liberal amount of lime, the Woburn soil contains only a small quantity, and the continued application of the ammonia salts over a long series of years reduced this to a seriously small amount. The obvious preventive course is periodically to add some lime to such soils. This was pursued at Woburn. To one-half of each of the affected plots some lime, two tons per acre, was applied in 1897, and almost immediately the crops became normal. The figures (bushels of corn per acre) are so interesting that those for the last few years may be quoted.

Plot No.	MANURE.	1898	1899	1900	1901	1902	1903
WHEAT.							
2a	Ammonia salts ...	27.8	19.1	12.5	.6	4.9	7.1
2b	Ammonia salts and lime ...	31.5	29.0	17.8	5.2	12.4	16.6
BARLEY.							
2a	Ammonia salts ...	7.6	5.5	5.6	8.2	.8	1.3
2b	Ammonia salts and lime ...	16.5	30.3	28.9	17.1	29.6	5.6
5a	Ammonia salts and superphosphates ...	4.5	6.0	12.3	15.5	12.8	1.3
5b	Ditto and lime ...	35.3	40.0	33.7	23.9	51.4	11.5

Lime was applied in 1897 to the *b* half plots, and a glance at the out-turns shows how effective this single dose has been. It has, indeed, proved a perfect cure for the evil. A cautionary word must be added to avoid misconception. Whilst liming the land is a usual way of supplying sulphate of ammonia with the base it requires, it would not answer the purpose at all to mix the two substances together previous to being used on the land, for the effect of this would be the liberation of the ammonia into the atmosphere, whereas we require it in the soil. The lime, if it is required at all, should be put on the land at an entirely different time from that when the sulphate of ammonia is used. Lime is best applied when land is being rough ploughed after a crop has been harvested, whereas sulphate of ammonia should be put into the soil either at the time of sowing or after the crop has grown two or three inches high.—(J. W. L.)

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EXPERIMENTS IN THE CULTIVATION OF DATES.—Arrangements have been made for starting experiments in the cultivation of edible dates (*Phoenix dactylifera*) in the province of Sindh. There have been in the past many experiments for the introduction of date cultivation in several parts of India, but these have almost invariably ended in failure. An examination of the reports of the experiments shows that these failures have generally

resulted either from the trials being made in localities where the climate is clearly unsuitable or from incorrect methods of cultivation. There is reason to hope that success may be achieved in Sindh. The climate should suit the edible date. Sindh is situated on the isotherm characteristic of this plant; it is practically a rainless tract and experiences the intense dry heat in which the date naturally flourishes. The canals can supply ample water for irrigation, and the drainage is good. Above all, inferior varieties of date are already successfully grown. Arrangements have been made for obtaining offsets of all the best varieties of date from Egypt, Morocco, Algeria, Tunis and Persia, which will be tried experimentally in Sindh under the supervision of Mr. Fletcher, B.Sc., Deputy Director of Agriculture, Bombay, who has practical experience of the Egyptian methods of date cultivation. There are thus reasons to hope that this trial will be more successful than those made in the past.—(F. G. S.)

NEW EXPERIMENT STATIONS IN MADRAS. The Madras Department of Agriculture has arranged to start a new experiment station at Attur in the Chingleput district. The site selected was originally acquired as a pumping station to determine the quantity of water which could be obtained from a well sunk on the margin of a sandy river like the Palur and to ascertain the best motor and pump for lifting the water. The supply of water in the well sunk on the river bank has been found to be unsatisfactory for irrigation on a large scale. It has now been decided to devote the land to the thorough trial of perennial and exotic cottons under irrigation and to the growth of fodder crops, the want of which is a noteworthy agricultural defect in the Chingleput district. Arrangements have also been made to start another new experiment station at Nandyal in the Kurnool district. This will mainly be devoted to the study of the varieties of cotton known as 'Northerns' and their improvement by selection and cross-breeding. It is also proposed to study the sorghum crop of the Nandyal valley, and possibly to introduce new varieties of indigo as a leguminous crop for rotation purposes.—(F. G. S.)

FORMALINE TREATMENT OF OAT SMUT.—For the prevention of oat smut, commercial formaline, which is a solution of about forty per cent. strength of formaldehyde, has of recent years been found remarkably useful, possessing some advantages over the more commonly employed copper sulphate. Some experiments to test its effect were carried out last year at Dehra Dun, where the disease is severe and causes an appreciable loss

annually to cultivators, the locality being one of the few parts of the United Provinces where oats are largely grown.

The extent of the disease was estimated on a number of fields, both by calculating the actual number of ears smutted per acre from actual counts in measured areas, and also by ascertaining the percentage of smutted to healthy ears. It was found that about 180,000 ears per acre were lost on an average in the fields examined, and that the percentage of smutted ears to healthy averaged ten and-a-half.

Four plots of about one-tenth of an acre each were sown. In one of these the seed was untreated. A second was sown with seed which had been soaked for four hours in formaline of a strength of one ounce to two and-a-half gallons of water (or one-tenth per cent. formaldehyde). A third received seed soaked in one-half per cent. copper sulphate for twenty-four hours, and a fourth was similarly treated with one per cent copper sulphate.

The germination of the plot treated with formaline was the best, both the copper treatments resulting in injury in this respect. The results as regards the degree of smut which appeared as the crop ripened were as follows :—

	Plot I untreated.	Plot II Formaline 1 oz. to 2½ gals. water.	Plot III ½% copper sulphate.	Plot IV 1% copper sulphate.
Number of smutted ears estimated to the acre	172,495	1,092	2,115	1,069

The formaline treatment was the most successful and gave a good crop, slightly better than the untreated plot. The crop on Plot III was only moderate, while Plot IV was distinctly poor. This was due to the long soaking in copper sulphate, which injured germination. Even with this long treatment the amount of smut in Plot III was nearly twice as much as in the formaline plot, while Plot IV had only slightly less smut than Plot II, and had it contained the same number of plants would no doubt have had proportionally more smut.

As regards convenience of treatment, formaline is the best, for it need only be poured into water and stirred with a stick when it is immediately ready for use. Ten gallons of the solution, requiring four ounces of formaline, is sufficient to treat enough seed for one acre. With copper sulphate, on the other hand, the "blue-stone" must be dissolved in the water, which takes some time. Formaline may be used in any sort of vessel, whereas copper sulphate must not be placed in an iron one.

The formaline treatment is more expensive, costing on a small scale about four annas an acre. On a large scale the cost can be much reduced, for the same solution may be used to treat several batches of seed. The profit resulting from the treatment is so considerable where smut is severe that the slightly greater cost of formaline as compared with copper sulphate makes very little difference. In Dehra Dun the extra yield from the formaline plot was about one seer in ten.—(E. J. B.)

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A PADDY DISEASE IN THE UNITED STATES.—Fungus diseases of paddy are not numerous in any country and are rare in India. Green smut (*Ustilago virens*) in Tinnevely, and a leaf spot (*Helminthosporium sp.*) in Bengal have been from time to time reported, but appear to be of no great importance. A disease locally known as *shabua* or *daidhara* sometimes does a considerable amount of damage in several districts of Bengal. Its cause is unknown, but it is allied to the destructive "brusone" of Italy. In a recent number of the *Tropical Agriculturist*, mention is made of a serious rice disease which has broken out in the rice-growing regions of South Carolina in the United States. The variety of rice chiefly grown there is that known as "Carolina Golden," which commands a fancy price in the American markets. In letters quoted from Mr. David G. Fairchild, Agricultural Explorer to the United States Department of Agriculture, some particulars are given of this fungus disease. Its cause is not yet definitely ascertained, but prompt steps are being taken to introduce similar rice from other tracts and from abroad, in the hope that some may prove resistant to infection. It requires little imagination to picture the devastation which would result from the appearance, in the densely-populated rice-growing areas of India, of a disease, which in Mr. Fairchild's words "has threatened the annihilation of the rice industry of the Carolinas."—(E. J. B.)

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RED ROT OF SUGARCANE.—This disease was exceptionally prevalent in Behar last year in estates which are still growing susceptible varieties. This appears to have been due to the unfavourable season experienced. It is stated that the severe cold of February, 1905, led to weak germination of the tops cut from those fields which had been kept for late seed. This was followed by the floods of August and September. A moist soil, due to insufficient drainage or prolonged floods, greatly favours the growth of the fungus *Colletotrichum falcatum*, to which red rot is due, and from October on the disease became more and more marked. There is little doubt that the parasite was already present in a considerable proportion of the seed used, and the almost ideal conditions for its growth which prevailed during the

latter half of the year led to the outbreak experienced. With the possibility of such unfavourable years, it is important to see that only thoroughly reliable cane varieties are grown on a large scale. Several of the varieties now grown have shown their liability to disease, and even where one of these has been successful for some seasons on a particular estate, the danger of a large amount of disease appearing in an unfavourable season is so great that it cannot pay to continue to grow it.—(E. J. B.)

* * *

EXTENSION OF POTATO DISEASE.—The gradual extension of potato disease (*Phytophthora infestans*) to parts of the world hitherto free still continues, though more than sixty years have elapsed since the first great outbreak in Europe and North America. The disease is supposed to have spread in the first instance from Chili, the original home of the potato. For many years Australasia remained free from it. About thirteen years ago, however, a mild outbreak occurred at Auckland in New Zealand. Nothing was heard of it again until 1904-5, when an epidemic occurred which is described in the last Annual Report of the Department of Agriculture in New Zealand, and is estimated to have cost the colony over £150,000. Prompt steps have been taken by the Department to introduce spraying, and it is anticipated that a vigorous campaign will be undertaken to stamp it out. The importation of clean seed from Australia, where the disease is believed not to occur, is also recommended.—(E. J. B.)

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DISEASES OF RUBBER TREES.—The Para-rubber tree (*Hevea brasiliensis*) is attacked by a canker caused by a fungus of the genus *Nectria*, an account of which was published in Vol. II, No. 29 of the Circulars of the Royal Botanic Gardens in Ceylon. The same disease is reported from one of the Burma rubber plantations, and the *Nectria* has been discovered in the cankers. Its treatment, which requires to be carried out systematically for several years, is to cut out the cankered parts and burn them. This should be done in sunny weather and when the trees are leafless. *Castilloa elastica*, the growth of which is said to be extending in South India, is subject to a more serious disease than the canker. Fortunately, it is probably confined to a small area as yet. This is the work of a *Diplodia* fungus which invades the entire woody parts of the tree, completely killing it. The only method of treatment is to uproot and burn the trees, so as to prevent spore-formation by the fungus, and thus save adjacent trees from infection. Though a drastic method, there should be no hesitation in employing it where disease appears, for the affected trees are useless and a source of great danger to their neighbours. Rubber planters who are wideawake may

be able, by taking prompt steps on the appearance of these diseases, to stamp them out before they obtain a hold. In these, as in most other cases of disease, early attack is half the battle.—(E. J. B.)

SISAL HEMP DISEASE.—A disease of cultivated Agaves, caused by the fungus *Colletotrichum Agaves*, is described by Mr. Helgcock in the 16th Report of the Missouri Botanic Garden. The same fungus has been found in several parts of India, and the disease which it produces has been a cause of some alarm on sisal estates. In America it has not been known to attack sisal, but in India it often does so. The older leaves are first attacked, small sunken patches appearing where the fungus has entered. These turn brown and dry up in the centre, while they spread at the margin. In the dried-up parts, spores are produced in little black clumps, which blow about and infect healthy leaves. This fungus has also been found on several occasions associated with the much more serious sisal disease in which the tips of the leaves wither from just under the thorn to half their length or more. In both cases the treatment is the same. All diseased leaves should be cut and burnt as soon as the patches appear. By this method the spread of the *Colletotrichum* has been checked in the Missouri Botanic Garden.—(E. J. B.)

ANALYSIS OF RUBBER.—The Imperial Institute proposes to undertake, during the current year, the examination of samples of rubbers from India. Samples of rubber of any importance will be examined chemically and also sent to brokers for valuation. Special attention will be given to *Ficus elastica* with the object of ascertaining if the produce of the Government plantations can be improved. In order to stimulate interest in the development of rubber planting in India, it is suggested that samples of rubber obtainable from the various Indian plantations, on which Para, Ceara and Castilloa rubbers are being tried, should be sent to the Imperial Institute for examination and valuation. All samples should be sent to the Reporter on Economic Products, Indian Museum, Calcutta, for transmission to the Imperial Institute.—(F. G. S.)

TESTING OF FIBRES.—Arrangements have now been made in the laboratory attached to the office of the Reporter on Economic Products, Indian Museum, Calcutta, for testing the strength of samples of Indian fibres. Where a complete examination is required, samples will continue to be sent to the Imperial Institute for analysis. The Reporter on Economic Products is also interesting himself in the improved preparation of Agave

fibre and the finding of brush fibres that could be produced in India.—(F. G. S.)

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THE COMPOSITION OF RICE.—The Curator of the Industrial Section, Indian Museum, has started an investigation into the composition of the many varieties of rice grown in India. Rice grain will be subjected to chemical examination with special reference to use as material for making sizes.—(F. G. S.)

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THE GERMINATION OF JAVA INDIGO SEED.—The substitution of the old variety of indigo grown in Behar (*Ind. sumatrana*) by the new and more valuable Java variety (*Ind. arrecta*) has been attended by a serious difficulty in the poor germination capacity of its seed. This has been found due to the existence of a hard seed-coat, which does not allow of the penetration of moisture. The difficulty has been met during the past two or three years by submitting the seed to a "scarifying" process in specially constructed machines, whereby the hard coat is sufficiently deeply scratched to allow water to penetrate. This treatment has proved perfectly satisfactory, but is somewhat difficult of application, due to the mechanical adjustments necessary in the machine to produce the most efficient results.

It has recently been found that the same end can be attained more simply, with more certainty of success, and at no greater cost (having regard to the price of the scarifying machine and its uncertainty of action) by treating the seed with strong sulphuric acid. This is accomplished as follows:—The seed to be treated is placed in a large water-tight wooden vessel, and undiluted commercial sulphuric acid is poured over it and stirred in with a wooden or iron instrument until every seed is wet; it is then left for the action to proceed for exactly half an hour. At the end of this time, a large quantity of clean cold water is rapidly poured on to the seed, which is thoroughly stirred meanwhile. The seed is then allowed to settle to the bottom of the vessel and the water poured off. A fresh supply of clean water is then added and the seed thoroughly washed and the water poured off as before. This is repeated a third time, after which the seed should be free from acid. It is then spread out in the sun to dry and is ready for sowing. The proportions of substances used for the treatment, which should be strictly adhered to, are as follows:—

Seed	...	...	...	...	...	½ maund.
Acid	...	...	...	...	...	20 seers.
Water	...	...	...	...	...	20 gallons (for each washing).

It is not recommended to treat more than ½ maund of seed at a time.

The method has the advantages that all bad, hollow seed and other, impurities float up, and may be poured off during the washing operations, and the appearance of the seed is very considerably improved. It is not advisable to keep treated seed through the rains unless it is put into sealed tins, as it is liable to deteriorate.

The method may be applicable to other "hard" seeds of which many cases are known to occur.—(C. B.)



SOIL INOCULATION FOR LEGUMINOUS CROPS.—The introduction of the cow-pea (*Vigna catenag*) into Behar as a green-manuring crop seems to have demonstrated the adaptability of the nitrogen-fixing bacteria, which form "nodules" on leguminous crops, to pass from one species of legume to another. So far as is known, the cow-pea has never before been grown on or near the soils at present bearing it; nevertheless the roots are heavily beset with nodules, and the crops obtained seem to indicate that no inoculation could improve matters. The explanation almost certainly lies in the adaptation of the nodule organism of some other leguminous crop to the cow-pea.—(C. B.)



RUBBER EXPERIMENTS IN BOMBAY.—Arrangements have been made to test some rubber-yielding plants in parts of the Bombay Presidency. These will form the subject of special study at the Bassein Botanical Garden. Two experimental plantations of about ten acres each will also be started by the Forest Department in the Kanara district with para-rubber (*Hevea brasiliensis*), but the Conservator of Forests is sceptical of success owing to the climatic conditions being unlike those obtaining in countries where this tree thrives. Some promising trials of *Ficus elastica*, the rubber tree of Assam, are in progress at Belgaum.—(F. G. S.)



POTATO CULTIVATION.—Mr. J. G. Stewart gives some useful information on this subject in the April number of the Journal of the Board of Agriculture. In discussing the selection of potato seed for yield, he says that two kinds of small potatoes must be considered; first, the late formed tubers of strong, robust plants; and secondly, the produce of plants of low variety. He considers that quite satisfactory results can be obtained from the former, as the tubers are small simply on account of their not having had sufficient time to reach full size, but with regard to those produced from poor plants, only inferior tubers can be expected. He thinks too that

if seed from the same stock is used for a number of years in succession, there will be an ever increasing produce of inferior tubers, and that this should be avoided. Experiments show that whole tubers about the size of a hen's egg generally prove the most profitable, and that it is unwise to make good a deficiency by cutting seed-size tubers. No reduction in yield need be feared from sets obtained by cutting bigger tubers. These, however, should more appropriately be used for market purposes.

If cutting is resorted to, the sets should be planted and covered with as little delay as possible. Exposure even for a short period may reduce materially the yield from cut sets. Should it however be necessary to cut seed some days in advance, it is advisable to dip them at once into finely powdered lime. The effect of the lime is to form a 'Scab' over the wet surface of the set, which prevents, or at any rate considerably retards, evaporation of moisture.

He then discusses the merits of storing seed in boxes commonly called 'boxing' the seed, as against 'pieing' or storing it in heaps or pies. He advocates 'boxing,' especially where early varieties have to be dealt with, and shows that this method gave a considerable gain over 'pieing.' It moreover minimises the damage to sprouts, and the destruction of the seed by rotting, which often takes place to a large extent in 'pies.' In India 'pieing' is entirely out of the question, as the potatoes would at once 'heat' and rot. They are usually stored under shelter in single layers on shelves made of split bamboos, allowing plenty of ventilation and a moderate amount of light. The seed generally sprouts before sowing time, and the removal from the shelves causes the destruction of the majority of the shoots. To overcome this difficulty and also in order to gain the advantage of an early start, the writer tried the experiment of 'boxing' the seed, and obtained the most satisfactory results. The boxes or trays, after being filled with single layers, were placed in the bamboo shelves. The sets sprouted and were carried in situ to the field, where they were carefully planted. The great advantages of this method are (a) the sprouts are not injured in handling; (b) there is very little loss of seed by rotting; and (c) the crop is earlier by a fortnight to a month, a matter of great importance where the production of early varieties is desired. The adoption of the method is indispensable where potatoes are being grown in India for the English market.

Mr. Stewart lays stress on the importance of a change of seed. This precaution is of even greater necessity in India, where the tendency to degeneration in a plant is greater than in a cold climate. In this country the use of fresh seed every year seems advisable.

Mr. Stewart discusses the difference in results obtained from mature and immature seed. In 1904 he obtained seed in an *immature* state by lifting the potatoes while the tops were still green and the skin of the tubers tender. For *mature* seed the same varieties were lifted at the usual time, when the tops were quite dead and the skins of the tubers tough. He obtained a very slight advantage from the use of immature seed produced in this way. He found that it could best be obtained by planting a late patch of potatoes. The produce from such a plot was mostly composed of 'seed' and 'small,' well adapted for seed purposes. The explanation given for the better results from immature seed, is that "they may contain more innate vigour than a small yet fully-matured potato not yet arrived at its full growth."

Mr. Stewart also deals with the choice of varieties, the use of fertilizers and other matters, but as his remarks do not apply to the conditions obtaining in this country, reference to them has been omitted.—(B. C.)

AGAVES IN THE PUNJAB.—The results of the trials of four varieties of agaves grown at Lahore are instructive. The percentage of fibre given by each variety was *Agave Americana* 1.55; *A. Americana* (narrow leaved) 1.80; *A. vivipara* 1.87; and *A. rigida* var. *Sisalana* 3.27. Sisal thus showed its great superiority as a fibre yielder.—(B. C.)

BARE FALLOW.—Professor A. D. Hall, of Rothamsted, has a very interesting note on this subject in the Journal of the Board of Agriculture for April 1906. It appears from his account that the practice of taking a bare fallow as a preparation for wheat was at one time an almost universal custom in farming. It was said to have been introduced into the British Isles by the Romans, and in mediæval times the only rotation consisted of wheat, barley, fallow, with beans instead of barley on the stronger lands. Towards the close of the eighteenth century the custom began to decline; green crops and turnips in particular had become part of routine farming, and the four-course system of turnips, barley, clover and wheat, began to spread over Great Britain. The more advanced farmers perceived the importance of keeping the land under crop, and the writings of Arthur Young, who was Secretary to the then Board of Agriculture in the early years of the nineteenth century, were unceasingly directed against bare fallows, with the result that the culture of turnips and mangels spread considerably. Experience, however, demonstrated in time the benefit of fallow, and the area under it gradually showed a tendency to increase. According to Prof. Hall a bare fallow may exert a beneficial effect on the land in three ways—by cleaning the land of weeds, by improving the texture

of the soil, and lastly by increasing its fertility. An explanation of the last advantage was, however, not possible until the discovery of nitrification some twenty years ago, and the investigations since made into the conditions favouring the process. All soils contain considerable residues of nitrogenous materials, which cannot reach the plant until they have been oxidised by various bacteria in the soil and so converted into nitrates. A summer's fallow in England provides conditions favourable to nitrification—warmth, aeration, the stirring of the soil, and the greater amount of moisture which results from the absence of a crop in dry soil. The following results of certain plots at Rothamsted in 1904 show that fallowing leads to a great gain of water to the soil :

PERCENTAGE OF WATER IN FINE SOIL.				
			Cropped.	Fallow.
1st	depth of 9 inches	...	17.4	17.2
2nd	do. do.	...	18.8	20.0
3rd	do. do.	...	20.1	22.3
4th	do. do.	...	20.9	23.1

The chief gain, however, from a summer fallow lies in the way nitrates are made and stored up in the soil for the benefit of the ensuing crop. The Rothamsted experiments illustrate the increase thus produced :

	WHEAT EVERY YEAR.		WHEAT AFTER FALLOW.	
	Grain.	Straw.	Grain.	Straw.
	Bushels.	Cwt.	Bushels.	Cwt.
Average crop per acre per annum, 1856–1902	12.7	10.0	17.1	14.2

It should, however, be observed that as the benefit of fallowing depends upon the formation of nitrates during the summer and their retention for the next crop, it follows that heavy rain during the winter may wash them entirely away and leave the land no richer. When followed by a dry autumn, the fallowing may produce an increase of more than half in the ensuing crop, whereas if the winter be wet, the increase is little or nothing.

Thus in England the summer fallows are only likely to be of direct benefit to the next crop where the climate is dry and no great amount of percolation takes place through the soil in the winter. Professor Hall adds

an example to show how much more advantageous it is to grow a clover crop in the place of a bare fallow, and concludes his remarks by saying that "a bare fallow can never be a directly profitable operation, and has no justification on free working land. But with strong clays in dry climates, it may often be necessary to clean the land and restore its friable texture; on such soils too there is least likelihood of loss through washing out of reserves of nitrogen which have been rendered available by the process."

These conclusions are no doubt entirely correct as regards England, but it may be worth while to consider the results of fallowing in India. The chief gain in fallowing is no doubt due to the same causes in India as in England, namely, the conversion of nitrogenous material into nitrates by the action of bacteria. This action is carried out in India under very much more favourable climatic conditions of heat and moisture, and it may safely be assumed that the production of plant food is, therefore, greater than in England. But the most important difference resulting from fallows in the two countries would probably be due to the difference in the movement of the moisture. In England, as Professor Hall observes, heavy rain may entirely wash away the products of nitrification. In many parts of India, however, and specially in the alluvium tracts, it is doubtful whether this is the case. Percolation in the true sense of the term can hardly be said to exist in these soils. The moisture during the heavy monsoon rains carries the soluble constituents along with it to a considerable depth, but on the cessation of the rains, this moisture, aided by the rapid evaporation caused by the heat of the sun and dry winds, assumes an upward movement and probably brings back to the surface, and renders available for the use of the plant, the salts which under conditions of percolation would have been lost. These considerations, and the fact that fallows are practised with such conspicuous success in India, induce an opinion on their utility in this country very different to that which Professor Hall holds in regard to the same practice at home. The process of fallowing in India will commence with the breaking up of the land after the spring crop is taken off it. The soil is then ploughed and weathered with a view to killing weeds, aerating, and completely driving the moisture away until the rains break in June or July. It will then be repeatedly ploughed and weeded during the monsoon, the neglect of these operations being highly detrimental to the making of a good fallow. Towards the end of the rains the new crop is put in, and the results obtained are in every way as good, if not better, than could have been obtained by the growing of a crop and the application of heavy manuring. Indeed, in the case of a crop like tobacco, results are never considered satisfactory without fallowing. Although a strict scientific investigation of the

action of fallows in India has yet to be made, there can be little doubt as to their value, and they supply strong evidence of the importance of the biological study of soils, a subject which is beginning to attract the attention of many.—(B. C.)



FRUIT IN THE NORTH-WEST FRONTIER PROVINCE.—Some interesting information has been received from the Revenue Commissioner concerning the fruit cultivation and trade of the North-West Frontier Province. The total area under fruit orchards is estimated at some 4,000 acres, of which no less than 2,700 acres are situated in the Peshawar district. The chief varieties of fruit grown in the several districts are:—

District.			Kind of Fruit grown.
Peshawar	...	...	... Grapes, peaches, Orleans plums (<i>alncha</i>), quinces, pears, figs, pomegranates, water-melons.
Hazara	...	...	... Apricots, loquats.
Kohat	...	...	... Grapes.
Kurram	...	...	... Grapes, <i>shatil</i> (a kind of peach).
Bannu	...	...	... Grapes, figs, dates.
Dera Ismail Khan	...	...	... Figs, pomegranates, dates.
Tochi	...	...	... Mulberry.

The produce of the last four districts is generally consumed locally, owing to their isolation from the railway. Dates from Dera Ismail Khan, however, find a market in Multan and other neighbouring districts. Apricots from Hazara and grapes from Kohat are sent to short distances as far as Rawalpindi and sometimes to Lahore. The only district, therefore, which exports fruit in considerable quantities is Peshawar.

The system of fruit cultivation is crude, quantity and not quality being the only object aimed at. An occasional grower has attempted to introduce improved varieties. Pomegranate is the fruit most extensively cultivated, and the Peshawar pomegranate is now considered to be superior in quality even to that of Jelalabad. However, it hardly justifies its local name of *Bedana* (seedless). The principal varieties of grapes are *Bedana* white and *Bedana* black with round berries, and *Husaini* with long oval berries. The two former are most liked for the export trade.

The annual exports of fresh fruits from Peshawar are estimated in maunds at pomegranates, 37,500; quinces and pears, 37,500; grapes, 4,500; peaches, 4,500; Orleans plums, 1,500; total, 85,500 maunds (3,130 tons). Pomegranates are exported to the whole of India and as far as Rangoon, quinces are mostly consumed in the Punjab, whilst pears go to Rangoon; the export of grapes and peaches is generally limited to Northern India; a small quantity only being sent to Calcutta, as they do not keep longer

than about five days : for the same reason, plums are mostly exported to the Punjab, only selected fruit being despatched to Calcutta. The whole of the fresh fruit exported is not the produce of the North-West Frontier Province. A considerable portion of the transborder fruit imported to India comes to Peshawar ; this chiefly consists of dried fruits (almonds, raisins, nuts and the like), but also includes musk-melons, grapes and pomegranates. A special fruit van is booked every day from Peshawar to Howrah during the busy months of September, October and November, in the height of the pomegranate, quince and pear season, which carries about 5,000 maunds a month. This is an ordinary railway van with no special arrangements for the preservation of the fruit during the journey. Fruit consigned to other stations travels as ordinary parcels. Complaints are frequently made of pilfering during the railway journey.

The trade is said to be steadily increasing, but the great drawback is the primitive system of packing and grading. Grapes, peaches and plums are packed in baskets made of reed grass to contain quantities of about 20 lbs. The basket is lined with green leaves or dry grass, the fruit being packed in layers, each covered with leaves or grass. Some dealers have recently commenced to pack grapes in small boxes lined with cotton after the fashion followed in Kabul, but the practice is still very limited. Pomegranates, quinces and pears are packed in crates, made of four strips of wood at the corners with a top and bottom, all covered with matting. Each crate contains about 100 lbs. of fruit. There is no knowledge of modern systems of grading and packing.

This short account of the Peshawar fruit trade shows that it has already reached fair dimensions, and there is ample room for its expansion. There is a large market down-country, which could be supplied by the North-West Frontier Province at remunerative prices, if the systems of cultivation, grading and packing are improved. At present much of the fruit grown is not suited to travel any distance. The districts of Peshawar and Hazara are in particular suited to fruit cultivation, and could raise large quantities of grapes, peaches and other fruits, for which there is a considerable demand. The improvement of the fruit industry will be one of the most important functions of the recently created Department of Agriculture of the North-West Frontier Province, with its experimental farm at Peshawar. And when the Imperial Fruit Expert is appointed, his principal duty will be the improvement of the fruit of the temperate zone of North-West India,—(F. G. S.)

LITERATURE.

ANNUAL REPORT OF THE CIVIL VETERINARY DEPARTMENT FOR THE YEAR 1901-05.

THE improvement of Indian agriculture is so closely connected with agricultural stock that the working of the Civil Veterinary Department is of particular interest to agriculturists. It is, therefore, satisfactory to find that the last annual report of the Civil Veterinary Department records marked progress in all branches of work. In past years the energies of the department have been almost exclusively devoted to the encouragement of horse-breeding, which is a matter of great importance to the Army and to some parts of India, but which resulted in the neglect of the very much larger interests of the agricultural population of all parts in cattle. Now that the Army Remount Department has taken over all matters connected with equine stock in the important horse-breeding tracts, the Civil Veterinary Department has been able to take up the much larger field of work connected with cattle.

The staff of both officers and subordinate establishments has been strengthened, but is still quite insufficient for the important duties entrusted to it. With the improvements contemplated in the existing Colleges and Schools, the arrangements for veterinary education will be fairly complete, for good training institutions will exist at Lahore, Bombay, Madras, Calcutta and Rangoon, which should be sufficient to meet the needs of all provinces. The prospects do not, however, seem to be sufficiently good to attract students without other inducements, for we notice that all the students at Calcutta, Madras and Rangoon are scholarship-holders. The general educational standard for admission is also very low everywhere except at Madras. With the reorganization of the subordinate establishment, it should be possible to raise the standard of admission and so secure students better qualified to undergo the course of instruction. The present stamp of Veterinary Assistant is hardly sufficiently well qualified, either in general or professional educational attainments, to perform efficiently the important duties expected of him. We understand that the prospects of the service will be improved by raising the scale of pay, by making it pensionable and by creating

superior appointments. This opportunity should also be taken to raise the standard of admission to the Veterinary Training Colleges.

The arrangements for the scientific investigation of cattle diseases are still inadequate to the needs of the country. There are at present only two research laboratories, Mukteshwar and Bareilly, where a very small scientific staff is employed. We should like to see a research laboratory established in connection with each College, and the scientific staff strengthened so as to permit of both teaching and research work at each institution. We understand that laboratories have been, or will be, established at Lahore, Bombay, Calcutta and Madras, but this will lead to little practical result unless the staff is strengthened, so that officers can devote some portion of their time to research into cattle diseases. There is no branch of veterinary work more likely to lead to practical benefits to Indian agriculture than the scientific investigation of the many tropical diseases of cattle, which cause such enormous animal losses. The published returns of the deaths of cattle from contagious diseases are admittedly quite incomplete, and the improvement of the system of registration is a matter which deserves attention. The work already accomplished at Mukteshwar is evidence of the practical results that may be anticipated from similar work on an extended scale. It has already resulted in the preparation of sera for rinderpest, anthrax and hæmorrhagic septicæmia, the first two of which are rapidly coming into general use, no less than 75,333 animals having been inoculated in the past year, of which only 373 died. All opposition to this method of treatment is said to be rapidly disappearing, so that there should be a very large field for its extension.

The Government Cattle Farm at Hissar, the management of which has been placed upon a more efficient footing, is doing a great work for Northern India in the breeding of good bulls for sale and distribution. The large breeding herd, which is rapidly being raised to the highest standard, produces stock such as cannot be obtained anywhere else in India. A small start has also been made in establishing in other parts of India cattle farms for the breeding and rearing of bulls. This is one of the most promising lines of work for the improvement of cattle, but it must be prosecuted with due judgment, for success at one farm does not necessarily mean that others will be similarly successful. Before a cattle breeding farm is started, a full inquiry should be made into the local conditions under which cattle are bred and obtained. Some parts of India are entirely unsuited to cattle breeding, whilst in others the supply of good bulls is already sufficient to meet the demand. The best test is probably whether there is any large demand for good bulls, which a Government farm could meet. At the present time there seems some danger that the policy of starting cattle farms may be pushed to

undue extremes. The cattle survey of India has been completed in the Punjab and Burma only ; such a survey should be insisted upon before a cattle breeding farm is started in any tract.

There has been a considerable increase in the number of dispensaries and of the number of cases treated at them, but the success of this branch of work is still very small. The average daily attendance of out-patients is only $2\frac{1}{2}$ patients at each dispensary, whilst the total number of both in-door and out-door patients averages only 957 a year. The causes of the unpopularity of veterinary dispensaries seem to demand inquiry.

This has an important bearing on the question raised at the last meeting of the Board of Agriculture, whether the staff of veterinary assistants can best be employed at fixed dispensaries or on peripatetic work in the district. There can be no doubt that, if funds are available, both branches of work should equally be carried on, but with a limited staff it would seem that the general body of agriculturists would derive more benefit from peripatetic work than from stationary dispensaries. The benefits of the latter are mostly confined to the population of the towns in which they are located, the large majority of animals treated being the property of a few well-to-do European and Indian inhabitants. This leaves the great bulk of the agricultural stock entirely untouched by this branch of the work of the department. It is true that veterinary assistants at dispensaries can be more easily supervised than those employed on peripatetic duty, but the remedy for this is a larger supervising staff and better trained assistants. So long as the subordinate staff are maintained by local bodies, district councils and municipal committees, their wishes must be considered, and as the members are generally residents of towns, their interests are concerned more with dispensaries than with peripatetic work. At the same time, we hope that the development of the department will not take the form of the establishment of additional dispensaries, which have been largely a failure in the past. The treatment of the individual sick animal is a matter of minor importance to the country compared with the advantages that would result from the suppression of the disastrous outbreaks of contagious disease. Indeed, the department should contemplate the time when, at least in the large towns, the treatment of individual sick animals may be left to private practitioners and not be the duty of a Government department. For the suppression of cattle plagues, development is required upon other lines ; first, research both at laboratories and in the field, and second, an organization for the introduction into general use of the results of such research. This organization involves the concentration of a considerable staff at the localities of cattle-plague outbreaks, which is impracticable when all the veterinary assistants are stationed at dispensaries

and are only available for service in the district under the management of each local body. Each Superintendent should have at his disposal an adequate staff of assistants for employment at outbreaks of cattle disease, wherever they may occur in his circle. For such purposes it may be necessary to provincialize this section of the staff instead of employing them under local bodies. When not engaged upon the suppression of cattle diseases, this establishment could be utilized in making cattle surveys.

Indeed, the energies of the department seem at present to be devoted too much to the treatment of the individual sick animal, both at the dispensary and on tour, to the detriment of larger and more important duties. We should like to see the policy of the department framed on broader lines, which should include a full inquiry in each tract into the local conditions of cattle breeding, feeding, management and the like. Such an inquiry could hardly fail to result in many practical suggestions for the improvement of the cattle. And in the treatment of disease, we believe that more good will result from a well-considered plan for dealing with cattle plagues rather than from dispensaries for the treatment of individual sick animals.—(F. G. S.)

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REPORT ON THE SUGAR-CANE EXPERIMENTS IN THE LEEWARD ISLANDS, SEASON 1904-05.—Although in India new varieties of sugar-cane have never been raised from seed, in the Leeward Islands the ease with which the cane seed germinates makes the production of new varieties of cane a much simpler matter, and indeed provides the planter with so many new varieties that he has not so much to be encouraged to discard the old sorts, as warned to be careful what he will select to take their place. The Imperial Department of Agriculture for the West Indies, however, supervises the very thorough testing which these numerous seedlings undergo, firstly, before they are grown under field conditions at all, and afterwards when they are grown as a field crop alongside the older canes under the same conditions of soil, moisture, tillage and manuring.

The report on sugar-canes in the Leeward Islands for 1904-05 deals with the experimental trial on a field scale of a number of selected varieties of sugar-cane, with a view to providing canes for cultivation which shall be heavier in yield, richer in juice and more resistant to diseases and pests than the varieties at present in vogue. The experiments are conducted at various estates in the islands of Antigua and St. Kitts, and it is important to notice that they are carried out by the planters themselves, the methods of cultivation employed being the same as for the ordinary cane crop of each estate. Since ratooning is the common practice of cane cultivation in the West Indies, the canes are kept under observation for as long a period as possible.

Not only is the ratooning quality of the variety thus accurately determined, but the influence of season may be noted; some canes, for instance, were better able to withstand the dry season of the year under report, and are found higher up in the list than their average place for four years, while as regards others the converse is the case. The highest yield of sucrose was from the cane named B. 156 which produced 5,578lbs. of sucrose per acre as the mean of 15 plots, whilst the White Transparent (Caledonian Queen) produced only 4,217lbs. sucrose per acre; owing to the dry season these were considered to be only half crops. In St. Kitts, White Transparent was nearly the best at every station where it was grown, with an average yield from five stations of nearly 8,000lbs. sucrose per acre. B. 208 did better than White Transparent on the average results, but was not so consistent.

It is a most satisfactory proof of the progress made in such work that out of nine canes introduced in 1901-1902, five are amongst the seven recommended by these experiments as reliable canes, thus showing the value of the preliminary trials in selecting canes worthy of consideration by the planter, which canes by the experiments above recorded are quickly introduced into cultivation and oust the older and less profitable varieties.--(R. C. W.)

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REPORT ON SERICULTURE IN BARODA. BY N. G. MUKERJEE, M.A., M.R.A.C.,
F.H.A.S., *Government Press, Baroda.*

Small experiments in sericulture at Songadh in the Tapti Valley of the Baroda State having given promise of success, the Baroda State secured the services of Mr. N. G. Mukerjee, Assistant Director of Agriculture, Bengal, for a period of three months, to investigate the possibilities of the introduction of a silk industry into the Baroda State. The results of his investigations are given in this report. Mr. Mukerjee considers that the climatic conditions of some parts of the south of the Baroda State, notably the Naosari and Amreli districts, are quite suitable both for the growth of mulberry and for the rearing of silkworms. The report lays stress upon the conditions of temperature necessary for the successful rearing of silkworms, a mean temperature of 75° F. with no variations between the limits of 60° and 90° in the rearing house being stated to be essential to the production of the best cocoons. He has framed a scheme for the introduction of a silk industry into the Baroda State, which includes the establishment of two schools at Viyara and Songadh, where students will be taught the methods of both silkworm rearing and silk-reeling, the starting of mulberry plantations for the distribution of young plants, the publication in Gujarati of a manual of practical instructions, and ultimately the establishment of

a reeling factory on a large scale. Given suitable conditions and a supply of mulberry, which will grow well in most parts of Baroda, the success of the industry will depend upon the initiative of private persons in rearing cocoons under proper conditions and also upon the initiative of the State in providing first experienced reelers and later perhaps a steam reeling factory. Mr. Mukerjee deprecates the system of producing coarse silk by reelers whose work is not tested and who are not under supervision. Under proper management, a high quality of silk may be reeled, which will find a market in India and Europe and realise better prices than would the coarse silk used only in Indian silk weaving factories. The report is not quite clear as to course which the author would recommend. Two schools and the trained students now available will, apparently, be able to train additional students who will at once be set up by the State as silk rearers and reelers. There is some possibility that a steam reeling factory may not be required, and the author, though suggesting the factory, is of opinion that 100 to 150 trained men set up in suitable places will be sufficient to establish the industry among the people. In the event of this failing, the State is to establish a steam reeling factory and buy cocoons. Probably the officers of the Baroda State have a clearer idea of their best course of procedure, and we may hope to see some line of action actively prosecuted, until the success or failure of the industry is clearly shown. There are two alternatives:—first, to train men in rearing only and rely upon a factory for reeling; secondly, to train men both in rearing and reeling with the object of encouraging a cottage industry, trusting to expert advice and supervision to maintain a high standard of reeling.

Mr. Mukerjee recommends the cultivation of mulberry trees in preference to the shrubs at present grown in Bengal. Whilst this recommendation is supported by many arguments, it has yet to be proved by actual experiment that the growth of trees is commercially more profitable than the system universally followed in Bengal of growing shrubs, which give numerous crops of leaves from heavy prunings. Mr. Mukerjee has also made a change in the Bengal reeling machine, which is claimed to be a great improvement. At present, a second person is required to work the winding wheel, whilst the reeler manipulates the cocoons; but Mr. Mukerjee has invented a pedal arrangement by which the reeler can also work the winding wheel. No figures are given to show that this improved machine has been tested by a careful trial against the common reeling machine. It is desirable that this should be done at an early date and the results published for general information. If it is successful, it will be an important improvement in the Bengal industry.

The introduction of a new industry, requiring the minute care and attention to details that is essential to success in silkworm rearing, is a matter of great difficulty, but the prospects in Baroda State are sufficiently favourable to justify the efforts.—(F. G. S.)

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THE COTTON BOLLWORM. BY A. L. QUAINANCE AND C. T. BRUES.—
U. S. A. Department of Agriculture. Bureau of Entomology, Bulletin 50.

The cosmopolitan pest known as the Bollworm in the United States forms the subject of an elaborate and thorough memoir, worthy of the foremost Agricultural Department of the world. In India this pest is not known to attack cotton, though it eats a variety of plants including many which it attacks in the States. Cotton, corn, tomatoes and tobacco are its chief foodplants in the United States, and the loss caused by this pest is very large. So cosmopolitan has this pest become that it is impossible even to hazard a guess at its original home. It is as likely to be a native of India as of any other part of the world, and it is so at home in all quarters of the globe that it has peculiar parasites in various localities.

The methods of control advocated in the bulletin are mainly based on changes in farm practice so as to circumvent the insect. These measures are based upon a close study of local conditions and are not of universal application. The principle is the same everywhere, but its application depends for success upon a high standard of intelligence in those who are to practise such measures.

In addition, the use of trap crops is advocated, as well as the application of arsenical poisons. The latter is probably equally efficacious against the bollworms of Indian cotton (*Earias fabia* and *E. insulana*). It is disappointing to find that no new methods, no new principles of control are elaborated by the painstaking work of the authors of this bulletin, and the conclusion may not unjustly be arrived at that only by study from new points of view will any progress now be made.—(H. M.-L.)

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THE MEXICAN COTTON BOLL WEEVIL. BY W. D. HUNTER AND W. E. HINDS.—U. S. A. Department of Agriculture. Bureau of Entomology, Bulletin 51.

This bulletin of over one hundred and sixty pages, an amplification of a previous bulletin, is published at the instance of Congress. It is a very detailed account of all that is known about the Mexican Cotton Boll Weevil up to the close of 1904, presumably as a source of information for Entomologists and all who are interested in this pest. As an instance of a detailed study of a very important insect, the bulletin is admirable; the most intimate

details of the life of the insect are discussed. Apparently even this minute study of the pest has not led to the discovery of any new principles in methods of treatment, and we may hope that the extremely elaborate work that is being done in the United States will ultimately be thoroughly assimilated and applied by the Entomologist or one of his staff. The present workers have evidently become so absorbed in detail that the main issues hardly appear.

The Mexican Boll Weevil is notorious owing to the short period occupied in establishing itself as the most serious pest of cotton in the New World. The damage caused by it in 1904 is estimated at six and a half crores of rupees (\$22,000,000), and it has steadily increased in destructiveness during the past five years.

It may be hoped that this insect will never spread outside the New World. It is now known from the United States, Cuba, Mexico and Guatemala. There is a very evident danger that the insect may be carried over the world in cotton seed, the result of which may be simply appalling. If its destructiveness is so great in the United States where it has some enemies, it would be far greater in Egypt, East Africa or India where its enemies will be non-existent.—(H. M.-L.)

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TWENTY-THIRD REPORT OF THE STATE ENTOMOLOGIST. ILLINOIS, U. S. A. A
Monograph of Insects Injurious to Indian Corn. Part II.

In this volume, Mr. S. A. Forbes reviews the insects which live upon the maize plant, including not only those which seriously affect the plant, but also the minor and unimportant pests. The author has in fact prepared a monograph of the insect fauna of the maize plant, so that a large number of insects are discussed.

Under "Insects Injurious to the plant above ground" sixteen "cut worms" (surface caterpillars) are included, including the common Indian species, *Agrotis ypsilon*. The world-wide Army worm (*Cirphis unipuncta*, Haw.) is another insect common in India, which is here stated to be "one of the most destructive of the insect pests of American Agriculture." Another widespread pest is the Corn worm (*Chloridea obsoleta*, F.), better known as the American bollworm of cotton; of this the author states that "the mastery of this pest in the corn field is still an unsolved problem." This is the caterpillar found so abundantly in India on gram, and which was widely destructive to this crop during the past cold weather.

The author also deals with the root webworms, the burrowing webworms, the stalk borer, the corn bill bugs, the chinch bugs and several species of grasshopper, making up a large total of insects of major importance injurious

to the crop above ground. If we add the insects injurious to the plant below ground (discussed in Part I.), the enemies of this crop become very numerous. Since the volume deals with the fauna of one State alone, it becomes evident that the magnitude of the work amply justifies the great attention paid to nomic entomology in the United States.

In dealing with the less important species, the author mentions a further formidable list of species. There are no species in this list which are also common to India, but there are what may be called equivalent species, *i.e.*, species which are extremely closely related and which work in the same manner in both localities. The Indian mothborer (*Chilo simplex*) has its counterpart in the American stalk borer (*Diatraea saccharalis*); the hairy caterpillars of India (*Diacrisia* and *Amsacta*) are represented by the "Wooly Bears;" the flower beetle of the East (*Chiloloba acuta*) is similar to the flower beetles and green June beetles (*Euphoria* and *Allorhina*) of this report; Blister beetles occur in both localities as do the plant bugs; the maize Fly (*Delphax psylloides*) of India differs little from the corn Delphax (*Delphax maidis*) of Illinois, and so on. We do not yet know all the Indian pests of maize, but it seems certain that the number cannot equal half that mentioned by Mr. Forbes.

In another group, the author discusses a very long list of insects "whose presence is not merely accidental but which do not injure the corn plant in any way to give them any appreciable economic importance." This section of the report is of extreme interest as showing what a large fauna gathers in a wildy-grown plant such as maize, and how varied is the insect life which lives in connection with such a plant.

Mr. Forbes' report is an example of the work that should be done in India, the detailed and prolonged investigation of the enemies of a single important foodplant by an observer who can give his attention to this particular research alone. The report is admirably illustrated, the excellent coloured plates adding much to its usefulness.—(H. M.-L.)

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* AMERICAN INSECTS. By VERNON L. KELLOGGY.

This general text-book on Entomology appeared in 1905 and is the most recent of the series of volumes that have from time to time condensed into a small compass a general view of the enormously variable insect world. Putting aside the complex system of classification, the volume is a readable and trustworthy account of the main activities of the insect world of the American continent. As is usual in an American volume, the system of classifica-

* A continuation of the reviews on pp. 178-183 of this volume.

tion differs so much from that in general use in such volumes as Sharp's "Insects" that the student is likely to be confused. In other respects the volume is one that should be of special value in the hands of students of entomology in India, the bionomics of insects being very prominently kept in view. No single volume can do more than give a general picture of some part of the activities of the insect world, and the author gives a readable account of the living activities of a very representative number of the insects of the American continent. The chapters on "Insects and Flowers," "Insects and Diseases," and "Colour and Pattern and their Uses" are excellent, and apply as closely to India as to other parts of the globe. The keys to the sub-divisions and the systematic entomology generally are best passed by, as they are naturally totally inapplicable to a tropical and oriental fauna such as that of India. As a reference book to the habits of a family, as an eminently readable review of the activities of the insect world at large, the book is worthy of a place, with those reviewed in earlier pages of this journal, on the shelves of an Agricultural College library.—(H. M.-L.)

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ANNUAL REPORT OF THE INDIAN SECTION OF THE IMPERIAL INSTITUTE FOR 1904-05.

This report gives an account of the work done for India at the Imperial Institute during the past year. Investigations have been made to determine the composition and commercial value of manganese ores, pottery clays and laterites, and the constituents of a large number of Indian coals have been determined. The investigation of the tanning materials of the barks of two common forest trees—*Shorea robusta* and *Terminalia tomentosa*—resulted in working out a process by means of which an extract may be prepared from these barks which produces satisfactory leather; this may prove a matter of considerable importance, if the process can be worked on a commercial scale in India. Numerous reports were furnished on samples of Indian fibres and rubbers. An India Trade Enquiry Office has been opened at 73, Basinghall Street, in the heart of the City of London, where any person can obtain information on Indian trade and commercial matters. The rearrangement of the Indian collections at the Imperial Institute is in progress, but much remains to be done to render the exhibits representative of the important resources of the Indian Empire. A special Cotton Exhibition has been arranged to illustrate the progress which is being made in the growth of cotton in the British Colonies and Dependencies and to exemplify the commercial uses of cotton. It is hoped to

improve and increase the samples representing the various types of Indian cotton and the fabrics made from them.—(F. G. S.)



HISTORY AND DEVELOPMENT OF AGRICULTURE IN THE MALAY PENINSULA.

BY H. N. RIDLEY, M.A., F.L.S., *Director of Botanic Gardens, S. S.*
(Agri. Bull., Vol. IV, No. 8.)

Agriculturists, who are sometimes sceptical as to the practical value of the work carried on by Botanic Gardens, would do well to read Mr. Ridley's able article. In a recent report on the Agriculture of the Malay States, Mr. Ridley considers that sufficient credit was not given to the work done by the Botanic Gardens in Singapore. He has, therefore, been at pains not only to trace the general history of Malayan Agriculture, but also the individual history of all the crop plants grown now or formerly in the Peninsula.

Mr. Ridley lays emphasis on the important fact, which those who deery or fail to appreciate this kind of work would do well to bear in mind, that the lessons taught by such institutions must be negative as well as positive; to quote his own words, "the knowledge that a plant of economic importance will not thrive in this country, is of nearly as much importance as the knowledge that it will prove successful." Dealing then with this one side of the work of a Botanic Garden, namely, the introduction, testing and distribution of exotic plants likely to prove useful in general cultivation, Mr. Ridley shows what has been done in the case of the Malayan Peninsula.

Though scraps of information may be gathered from scattered sources about the agriculture of Malay under Portuguese and Dutch administration, it was not until the appointment of Christopher Smith to the Botanic Gardens of Penang at the beginning of the last century that we find any really systematic work was done. From then until the appointment of Mr. Menton in 1875 to the Singapore Botanic Gardens, the history of Malayan agri-horticulture is a disheartening one. Sir Stamford Raffles founded two Botanic Gardens, one at Ayer Hitam in Penang in 1822, and one at Singapore in 1823, but with his retirement progress began to dwindle. Since Mr. Menton's appointment, however, progress has been rapid, and the Peninsula is now in possession of two well-organized institutions at Singapore and at Penang.

The value of the work done by these institutions, in introducing exotic plants to the notice of the planters, can scarcely be overestimated in a country where the system of agriculture is such as we find carried on in

Malay, where one crop at a time is grown to the almost complete exclusion of all others; for if at any time it is found that the crop under cultivation ceases to be remunerative, it is of the utmost importance that no time should be lost in replacing it with thoroughly acclimatised and healthy specimens of some other crop. This may be looked upon as a special branch of the work of a Botanic Garden.

It may be well to call attention to an important economic principle which is well exemplified in the history of these States. For each crop of economic importance there is probably a locality where from conditions of soil and climate it may be grown most profitably; until this is ascertained, other localities may at first grow it at a profit, but sooner or later the price will fall until a level is reached at which none but the most favoured locality can afford to grow it. Such was the case with Liberian Coffee, which dropped out of cultivation in the Malayan States when the vast output from Brazil caused the price to fall below a rate remunerative in Malay.

Mr. Ridley has called attention to the fact that the European planter and the native planter seldom cultivate the same crops. The European usually grows exotic plants and is seldom successful with the plants cultivated by the natives, while the latter seem to be too conservative to adopt new crops.

For the main object of this article, Mr. Ridley has succeeded in writing a most able justification of the Singapore and Penang Botanic Gardens: and as an apology, using the word in its classical sense, for the general system of scientific Agri-Horticulture, the lessons to be drawn therefrom are far-reaching in their application.—(R. C. W.)

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THE FERMENTATION OF TEA, PART I. BY HAROLD H. MANN, ESC., *Indian Tea Association, Calcutta.*

We welcome this very interesting pamphlet as an addition to the author's previously published works on the ferment of the tea leaf (The Ferment of the Tea Leaf, Part I (1901), Part II (1903), Part III (1904), Indian Tea Association, Calcutta). In his earlier publications Dr. Mann has shown that the changes which take place in the tea leaf during the manufacture of finished tea are mainly, if not entirely, brought about by the action of an oxidising enzyme on the other constituents of the leaf, that this enzyme is developed during the withering process, and that bacteria play no useful part in the operations and should be excluded as far as possible. In the present pamphlet the nature of the chemical changes taking place during the process is dealt with, and a somewhat complex subject disposed of in the same popular and practical manner which has characterised the author's former work.

It is pointed out that, so far as is yet known, only three constituents of the tea leaf go to determine its value—the essential oil, the caffeine, and the tannin. The first two of these substances are speedily dismissed since it seems that the essential oil is a little known body, and the caffeine, though perhaps of medical interest, is of little consequence in determining the trade value of a tea. The tannin is of more importance. Dr. Mann gives figures to show that the value of a tea may be directly traced to its contents of this constituent, since on it depend to a very large extent the pungency, the colour and the total dissolved matter of the liquor obtained on infusion. The pungency would seem to be conditioned mainly by unfermented tannin, the colour by fermented tannin, and the total soluble matter by both together. It, therefore, becomes of prime importance to trace the progress of the changes which take place in the tannin during the fermentation process, so that it may be regulated in such a manner as to produce a tea containing the most desirable quantity of this substance in the fermented and unfermented forms.

In order to do this, Dr. Mann has carried out a very careful series of experiments in withering and fermenting teas under varying conditions, estimating the total soluble matter and soluble tannin produced in each case. In connection with withering, it is found that both the total soluble matter and the soluble tannin continue to increase in quantity during the process, provided the leaf is kept moist and that no fixed maximum point is arrived at, as was found to be the case in the development of the enzyme. If the leaf is allowed to dry up, however, a reduction in the total soluble matter immediately takes place owing to oxidation of the tannin. Dr. Mann draws attention to the necessity which this indicates of avoiding bruising or breaking the leaf before and during spreading in the withering house, since, if this occurs, drying up will result around the wounds and a tea of reduced value be produced.

During the fermentation process, the tannin and the total soluble matter are found steadily to decrease until a fixed minimum is eventually arrived at. The rate of change is found to be considerably influenced by the temperature at which the operation is conducted, as well as, of course, by the heaviness of the rolling to which the leaf is subjected before fermentation, since thereon depends the amount of ferment and fermentable substance which are brought into contact with one another. It is shown that with a normally rolled leaf, the fermentation is complete (that is to say the soluble constituents have reached a minimum) in between five and six hours at 80°F., which has been found to be the optimum temperature at which to conduct the process.

Like other investigators into industrial fermentation processes, Dr. Mann was led away by the fascinating idea of conducting his fermentation at a

higher temperature than is usually employed, so as to hasten the process and, if possible, render it continuous ; but, again, like other investigators, he was doomed to disappointment. It was found that at a temperature very slightly higher than the optimum, secondary actions come into play, and dark brown undesirable products are formed due to superoxidation. The conclusion is, therefore, drawn that the fermentation should never be conducted at a temperature above 82°F., and, as an outcome of this, useful practical information is given as to the necessity for thin spreading in the fermenting house, and quick firing at the conclusion of the process. It is further concluded that in all "the plains districts of North-East India the idea of fermenting in the factory itself must be given up," since it seems hardly possible to ferment at the necessary low temperature in any practicable manner. Several useful hints are given on the construction of fermenting houses so as to attain the three main conditions which have been found desirable, *viz.* :—(1) the maintenance of a temperature of 82°F., or below ; (2) the production of a saturated atmosphere ; and (3) the provision of conditions as free as possible from injurious microbes, in other words, of extreme cleanliness.

Some interesting observations on the effect of light of various colours on the fermentation process are recorded. Doubt appears to exist as to the most desirable method of lighting the fermenting house, and windows of various colours have been adopted by many planters, whilst, in some cases, windows are excluded almost entirely. As a result of his experiments, Dr. Mann concludes that the fermentation is retarded by blue light, but that white, red, and yellow lights are without effect on the rapidity of the process, whilst the ultimate result is the same in every case provided direct sunlight and glare are avoided. So far as we are aware, this is the first case in which the effect of illumination on enzyme action has been studied. The subject seems worthy of further investigation which may lead to valuable applications to other fermentation industries ; useful information might perhaps be obtained, for instance, on the lighting of malting houses.

On this subject, as on several others with which he deals, one cannot but regret that Dr. Mann has not had the opportunity to give us some more exact scientific data. As a practical guide to tea planters, and as affording scientific explanations of many of their well recognised practices, the pamphlet before us is a model of what it should be, and doubtless it is right that it should be written with these objects primarily in view ; but there are several points on which we would welcome more detailed information, not only as assisting us to understand more fully the subject under discussion, but as enabling us to argue more readily from the case of tea to that of similar

problems. We cannot, for instance, readily grasp how the explanation given by Dr. Mann on page 5 of his report of the mode of action of the enzyme fits in with his observations, for, if the tannin of tea is a glucoside, it would seem essential that a hydrolytic enzyme be present to bring about the separation of the sugar: mere oxidation can hardly account for this, though it may be, and evidently is, a secondary action. No doubt a description of the "many experiments" which Dr. Mann refers to as being "out of place to detail" would explain this. Again, we should like to have some experimental verification of Dr. Mann's statement that the tannin of tea is peculiar in not being precipitated by gelatin, and some details of his method for determining the carbonic acid gas exhaled by the tea leaf during withering, referred to in the footnote to page 7, would be very interesting.

But we are, doubtless, asking too much from a report designed to edify, and not to terrify, the members of the Indian Tea Association. We can only hope that a scientific officer in such an unique position in India as Dr. Mann, will see fit at some future date to publish in some scientific journal an account of the scientific details of his work for the benefit of his fellow-workers.—(C. B.)

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